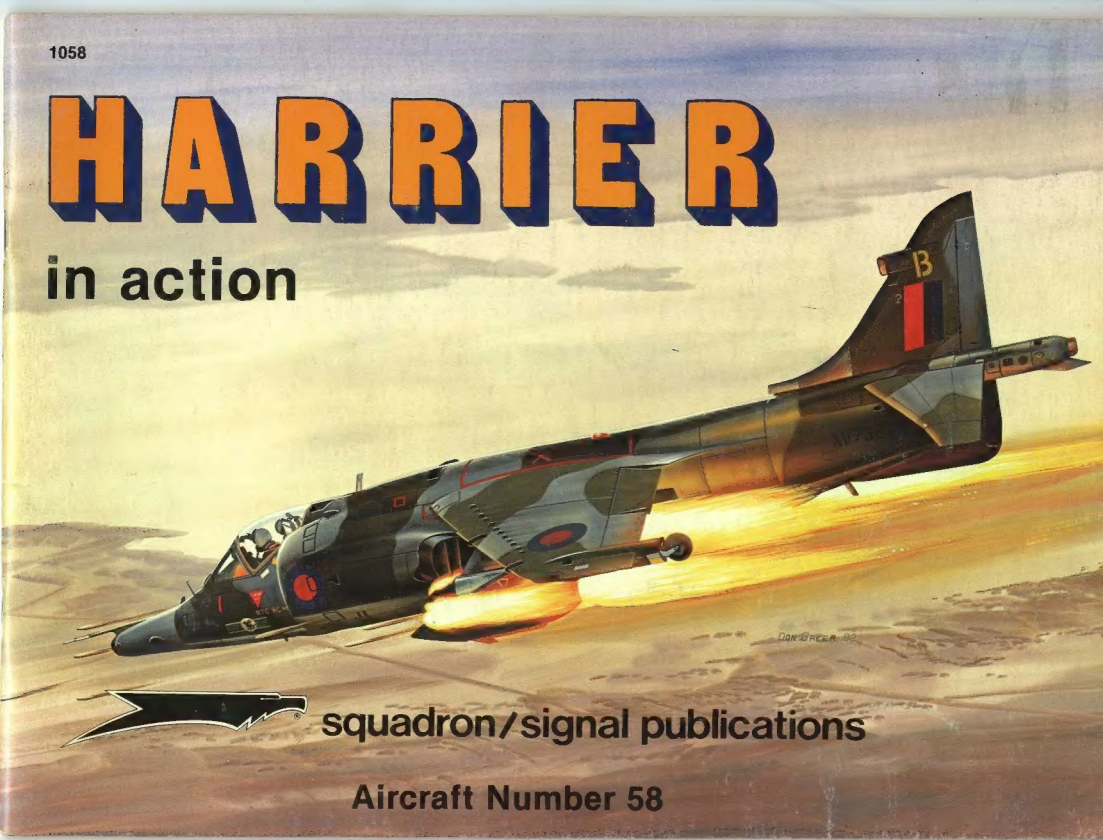
1058

HARRIER

in action

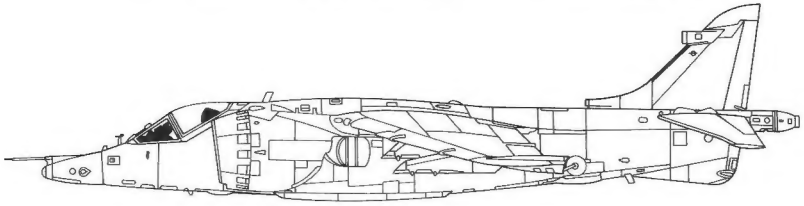


squadron/signal publications

Aircraft Number 58

HARRIER
in action

by Don Linn
illustrated by Don Greer



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Harrier GR MK.3 Laser Nose of No.3 Squadron firing a salvo of rockets from a pair of SNEB rocket pods.

ISBN 0-89747-139-3

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Acknowledgments:

The author wishes to express a special thank you to; Lt. Gen. Thomas H. Miller, USMC (Ret.), Capt. D. 'Chuck' deVlaming, USAF, the Ministry of Defense, U.S. Marine Corps, British Aerospace (Hawker Siddely) and McDonnell Douglas for their help and cooperation in the preparation of this book.

Contributors:

Jim Sullivan	M. J. Axe
Steve Daniels	P.V. Wijngaarden
Lindsay Peacock	Pieter Balkhoven
Don Spering/A.I.R.	No.1 (F) Squadron
Paul D. Stevens	233 OCU
A. Hafter	A. L. "Andy" Mutzig
Salvador Mafe Huertas	Robert D. Ward
Jack Urbanski	John Fletcher
Gary Emory	Ed Miranda
Chris Pocock	Wide World Photos
Kurt Thomsen	Tom Chee
Bruce H. Johnson	Stephen Wolf-Flightlines International

(Right) The Harrier's unique ability of vertical take off and landing allows it to operate from virtually any place. (British Aerospace)


VMA-513

INTRODUCTION

The worth of a fighter aircraft cannot be fully realized until it is tested in combat, wargames and mock combat are fine for training, but until an enemy has been met and locked in a life or death struggle, the metal of either a fighting man or fighting aircraft can not be ascertained. The Harrier, after some thirteen years of operational service, has met the enemy, locked him in mortal combat, and come away the winner. Operating under severe winter weather conditions, in the rough wind swept South Atlantic seas off the Royal Navy assault carriers HMS Hermes and HMS Invincible, Royal Navy Sea Harriers engaged Argentine Air Force fighters, naval vessels and ground targets with great success. During these combat actions in the South Atlantic the Harrier, the worlds first operational Vertical/Short Take Off and Landing (V/STOL) jet fighter, has proven its worth.

The road to success has been a long and hard one, a road that was paved with hard work, perseverance, disappointment and uncertainty dating back to early 1957 and the Harrier's predecessor, the Hawker Siddeley P.1127. The P.1127 was the end result of a private, but very determined effort by both Hawker Siddeley and the Bristol Engine Company, the manufacturers of the Pegasus turbojet engine which was the heart of Hawker's V/STOL program, to produce a practical V/STOL military aircraft.

Hawker's Chief Designer, Sir Sydney Camm, led the design team that began work on Project 1127 in 1957. Working under Camm were two young design engineers, Ralph Hooper and John Fozard, who would play a major role in designing the P.1127, and continue their efforts throughout most of the Harrier program. From those first design discussions in 1957, the P.1127 finally emerged, a V/STOL that was destined to become a new chapter in aviation history. It took nearly two years, until June of 1959, with Bristol making a maximum effort, to develop the BE.53 turbojet engine, before the project started to take shape. The BE.53 was the key to the whole program and it wasn't until the following August that the first positive results were realized when bench tests of the new turbojet achieved 11,000 lbs. static thrust.

Meanwhile, Hawker was struggling alone, operating solely on company funds when the Ministry of Supply authorized the building of two research prototypes. The official performance and specifications were written as Experimental Requirement E.R. 204D. This provided Hawker with the badly needed financial backing to contine with the P.1127's development. This of course came after Hawker had spent millions of pounds of company funds on design work. However the P.1127 program had been progressing well at Hawker's Kingston-on-Thames factory, and on 17 August, 1960, the first P.1127, carrying the serial number XP831, was rolled out. Five weeks after roll out, nearly two years after Hawker decided to proceed with the project, the P.1127 prototype made it's first flight from Dunsfold. With Bill Bedford, Hawker's Chief Test Pilot at the controls and with all sorts of instrumentation wires hanging off the aircraft (to save weight all but the most rudimentary instruments had been removed), the aircraft lifted vertically into the air. To prevent mishaps the machine had been tethered by 18 inch cables, and so, while this historic flight was neither high nor of long duration it was extremely successful.

On 19 November, after nearly a month of tethered hovering trials, XP831 made the first tether free hover at Dunsfold — with typical British understatement it was to very little fanfare. As testing continued during the months to follow, there appeared to be a noticeable lack of interest in the P.1127 among the NATO customers that Hawker was try-

Tethered to the ground so the machine could rise no highter than eighteen inches, and with Bill Bedford at the controls, XP831 hovered for the first time. To save weight all but the most essential instruments had been removed, consequently all sorts of wires running to instrumentation can be seen hanging from the aircraft. (British Aerospace)

XP836, the second prototype photographed prior to its fateful crash on 14 December, 1961. Bedford was at the controls during a routine flight to test airframe flutter when he experienced engine trouble. The crash was the first in the Kestrel program, and Bedford ejected safely at about 200 feet over the Royal Naval Air Station at Yeovilton. (British Aerospace)

ing to solicit. NATO even issued a new service requirement, NBMR-3, which called for an aircraft with capabilities that far exceeded those of the P.1127.

At the end of February, 1961, XP831 was transferred to the Royal Aircraft Establishment Bedford in preparation for the first conventional flight trials. Again Bill Bedford was at the controls for the twenty-two minutes of the P.1127's first conventional flight on 13 March. But the most important flight was yet to come...to hover and transition to conventional flight, and then transition back to hover again! After six months of testing and development work the first step to transitional flight came when Hugh Merewether, one of Hawker's noted test pilots, now taking part in the P.1127 program, flew the length of the Dunsfold runway at a height of fifty feet at fifty knots, stopped in mid-air, hovered, and then set the P.1127 down vertically on a pre-arranged landing spot. This important first step demonstrated the capability of the Pegasus engine to produce enough thrust to allow the pilot to land vertically, on a predetermined landing site at the pilot's discretion. While the P.1127 was a long way from being an effective military strike aircraft, it had taken another step toward the V/STOL concept and it proved the theory of vectored thrust.

Now that it was possible to control the P.1127 in a hover, the next step was to transition from hover to conventional wing-borne flight and back to hover again. On 12 September both Merewether and Bedford made complete flights.

The first setback in the P.1127 program occurred on 14 December, 1961, when XP836, the second prototype was totally destroyed in a crash. Bedford was flying a routine conventional test flight in XP836, which had only joined the program six months earlier, when he developed engine trouble. Bedford, not far from the Royal Naval Air Station Yeovilton, decided to make an emergency landing. Making a conventional approach to Yeovilton's runway 27 at about 200 knots, the aircraft began to roll and become uncontrollable. Bedford, feeling he could no longer control XP836, decided to eject. At 200 feet above the runway Bedford pulled the ejection seat handle attached to his Martin-Baker seat. Luckily, Bedford landed unhurt, but if he had waited a few seconds to eject, he would have been too close to the ground for his parachute to open. The cause of Bedford's crash was the loss of one of the front nozzles, one of the cold nozzles, which for some reason, possibly stress, simply broke away from the fuselage. It is ironic to note that the nozzles were made of fiberglass and the decision had already been made to replace them with steel nozzles when the accident occurred.

On 8 February 1963, Bill Bedford, whose name has become almost synonymous with the development of the P.1127, carried out vertical landing trials on board the aircraft carrier HMS Ark Royal. The results of these carrier trials aboard Ark Royal proved the P.1127 was capable of carrier duty and could be integrated into existing carrier operations with few difficulties. The fear that the hot jet exhaust, vectored down for vertical take offs and landings, would damage the flight deck proved groundless. The P.1127 was living up to expectations, so well in fact that Hawker was anxious to show off its capabilities at the 1963 Paris International Air Show. But what Hawker had hoped to be their crowning moment ended in embarrassment and near tragedy.

Two of the remaining four P.1127s went to Le Bourget to demonstrate Hawker's progress in V/STOL. The two P.1127s took off at the International air meet and were performing beautifully as the crowd and representatives of various governments watched, obviously impressed with the P.1127s performance. Suddenly, as Bedford was landing vertically on the grass next to the French President's viewing platform, the P.1127 lost lift and dropped heavily to the ground. A shaken but otherwise unhurt, Bedford climbed out of the severely damaged XP831. The cause of the crash was later traced to dirt blocking the pressure reducing valve which resulted in a failure of the air motors that control the rotation of the exhaust nozzles, causing a loss of control of lift and forward speed. The French, with Mirage also involved in a VTOL project, took great delight in the British embarrassment. XP831 was repaired and after serving in further tests, was retired to the Museum at RAF Henden, where it resides today.

The remaining three P.1127s, XP976, XP980 and XP984 continued flight trials at the

Royal Air Force Establishments Bedford, Farnborough, Boscombe Down. The successful results of the P.1127 program was now beginning to draw more than casual interest from the United States and Germany. Both countries were already working on their own V/STOL projects, Germany with the VAK-191 and the United States with Bell's X-14 and Ryan's X-13. However, these projects were not achieving the results that Hawker was enjoying with the P.1127. Each had been paying a great deal of attention to the remarkable success of the little P.1127 and it was a great relief to Hawker Siddeley when the United States suggested that all three countries should pool their resources and help in evaluating the British V/STOL aircraft from Hawker. It was proposed by the United States that all three countries together form a single evaluation squadron of P.1127s and continue the flight test program for the benefit of all concerned.

THE TRIPARTITE NINE

The end result of this joint initiative was the birth of the Tripartite Evaluation Squadron (TES), comprising pilots from the United States Air Force, Navy and Army, The RAF and the Luftwaffe. The commanding officer was RAF Wing Commander David Scrimgeour, with two deputy commanding officers, USN Commander J.J. Tyson and Colonel Gerhard Barkhorn of the West German Luftwaffe. Barkhorn was the oldest of the pilots, in his mid-forties, he had been the second highest scoring Luftwaffe ace during the second world war with 301 confirmed victories. Fortunately most of the kills had been scored on the Eastern Front. In all, the squadron had a compliment of 17 officers and 112 enlisted men from the United States, German and Britain. Nine Hawker Siddeley P.1127 Kestrels, as the little V/STOL aircraft had been named, were placed on order.

The Tripartite Nine, as the Squadron became known, was officially formed on 1 April 1965 at the RAF's Central Fighter Establishment at West Raynham. This was after the pilots had already completed a pre-conversion course readying them to fly the new Kestrel. Following this initial familiarization with British instrumentation, conducted in Hawker Hunters, and an introduction to hovering and vertical flight conducted in helicopters, the pilots went to Dunsfold for V/STOL conversion training in the Kestrel.

Nine new Kestrel F(GA) MK.1 aircraft were received by the Tripartite Squadron, each country flying and maintaining three airplanes. The Kestrels were an updated and improved military version of the original P.1127 powered by a Pegasus 5 engine delivering 15,200 lbs. of thrust. The fuselage had been widened and lengthened to accomadate the new Bristol turbojet. It also included a thicker swept wing with weapons hardpoints, a nose camera, and a taller fin. Serial numbers were XS688 to XS696.

The test program proved beyond any doubt that vectored thrust had a viable military application, and the Kestrel had performed extremely well operating from unimproved landing sites with very little ground support. But when it came time for the United States and Germany to exercise their prearranged option to purchase their Kestrels upon completion of the TES program, the Luftwaffe declined. The U.S. on the other hand, not only bought the three Kestrels they flew and maintained, they also purchased the German-operated Kestrels as well. The six Kestrels were shipped to the United States in 1965 for continued testing and evaluation at NAS Point Mugu, Edwards AFB and NATC Patuxent River. The Kestrels, under the U.S. designation XV-6A, were flown by U.S. Navy, Army and Air Force pilots, each evaluating the V/STOL capabilities of the Kestrel for their service's particular needs.

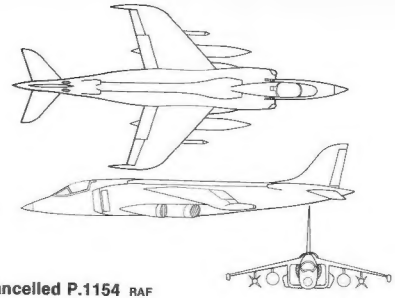
Unfortunately for Hawker no purchase agreements were generated from any of the countries involved in the Tripartite Evaluation. Even the successful U.S. testing and favorable ship board trials on the USS Raleigh and USS Independence failed to produce any further interest in the Kestrel, or the XV-6. By 1967 lack of interest had put an end to the Kestrel, or so it seemed.

Hawker had designed the P.1127 as an engineering solution to the jet V/STOL and as

The first of the Tripartite Nine, XS688, during a training flight. All of the first fifteen P.1127s were in natural metal, the TES Kestrels were equipped with camera noses causing the pitot tube to be relocated to the fin. The serial number and the company name were Black, and the colorful tri-national insignias were carried on the wing positions. (British Aerospace)

XV-6 No. 2, USAF serial 64-18262A on display at Wright Patterson AFB, 5 June 1971. (Paul D. Stevens)

After the Tri-Service evaluation team finished with the XV-6 Kestral, at least one machine was turned over to NASA for further trials. (Jim Sullivan)



cancelled P.1154 RAF

such, it was a resounding success. As early as 1960, during the first trial hovers of XP831, the Hawker Design Team had turned their attention toward producing a practical supersonic military V/STOL aircraft. Under the project designation P.1150, the proposed aircraft was twice as heavy and considerably larger than the subsonic Kestral. Powered by a Pegasus engine having a Plenum Chamber Burning (PCB), the design had a projected speed above Mach 1.7. The PCB, whereby fuel was burned in the fan discharge air, provided an increase in payload at low level and enabled supersonic speeds to be reached in level flight. Unfortunately during the summer of 1961 Hawker received NATO Specification NBMR-3 which showed even the P.1150 to be too small to meet NATO requirements.

Back to the drawing boards and a new design proposal, the P.1154, designed around a new vectored thrust engine from Bristol, the BS 100. In January 1962 the P.1154 design was submitted to NATO Staff and during the Spring of 1962 the Hawker design emerged as the technical winner, although this honor was some what diluted by French politicing when the Dassault Mirage VTOL proposal was declared a joint winner despite the French design having a much lower payload and requiring very complex field support.

The British Government urged the Royal Air Force and the Royal Navy to accept a single design capable of: single seat low level strike, with a secondary supersonic intercept for the RAF, and a two seat all weather shipboard interceptor, with a secondary low level strike capability for the RN.

For a year and a half design studies were conducted trying to reconcile the two separate service roles, with little success. In 1963 a final design that was a one hundred per-cent bi-service version of the P.1154 was rejected by both services as being an over compromised mediocrity. The Navy purchased the Spey Phantom II instead, however the RAF initiated a development prototype of the P.1154(RAF) powered by a new generation of BS developing over 30,000 lbs. of thrust. However, when the prototype was about one third complete, the Labour Government, which had earlier come to power, cancelled the project. The P.1154, a design ahead of it's time, went into hibernation. Following the RN's lead the RAF purchased Phantom IIs to replace the cancelled P.1154s.

Simultaneous to the cancellation of the P.1154, however, was the announcement that the RAF would be permitted to develop an advanced version of the Kestrel as a V/STOL close support fighter. Under the designation Project 1127(RAF) the Hawker Team began to redesign the Kestrel in order to provide it with P.1154 capabilities (with the notable exceptions of payload/radius and supersonic speed).

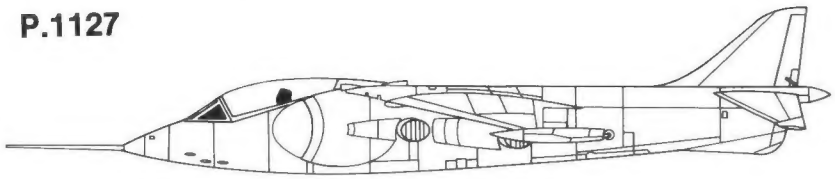
THE HARRIER

To transform the experimental V/STOL Kestrel into the warrior demanded by the RAF, required no less than 93 per cent of the drawings being changed. Six preproduction aircraft were ordered, followed by an order for sixty production machines. The preproduction aircraft were serialed XV276 to XV281. On 31 August 1966, powered by a 19,000 lb. st (thrust) Pegasus 101 engine, the RAF's newest warrior flew for the first time, and in full upper surface camouflage. Even as the first drawings for the new machine were being issued, a new and more powerful version of the Pegasus engine was underway, with a newly designed fan having transonic blading and more airflow capacity, the new Pegasus 103 engine produced 21,500 lb st. Bench tests of the prototype powerplant and flight tests of XV276 showed that redesigned and enlarged air intakes would be required if the full power potential of the new V/STOL was to be realized. It was too late to change the configuration of the first five preproduction machines, however XV281, and all production aircraft from XV738, incorporated the redesigned air intake. Later, both the second and third prototypes, XV276 and XV277, had their air intakes enlarged to the new configuration.

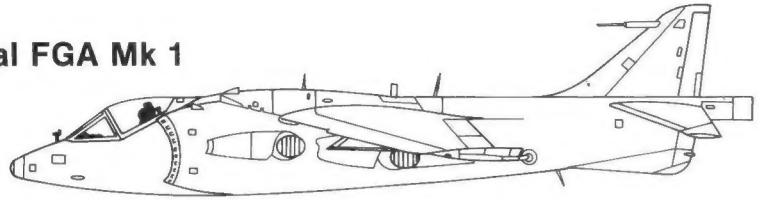
Because development of the new engine fan took much longer to produce than anticipated, it was decided to produce an interim version of the Harrier powered with an uprated Pegasus 101 engine. Under the designation Pegasus 102, thrust was increased to 20,000 lb. by overspeed which caused problems of engine surge and hovering thrust center. These proved to be easily solved and on 14 July 1967, the final preproduction prototype, the one on which the production machines would be based, took to the air. Almost exactly ten years after the first tentative talks, the worlds first V/STOL fighter aircraft was going into production.

Developments

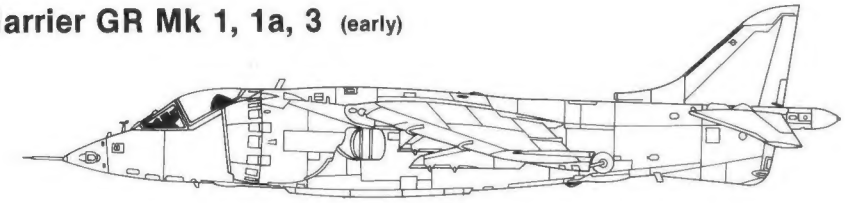
P.1127



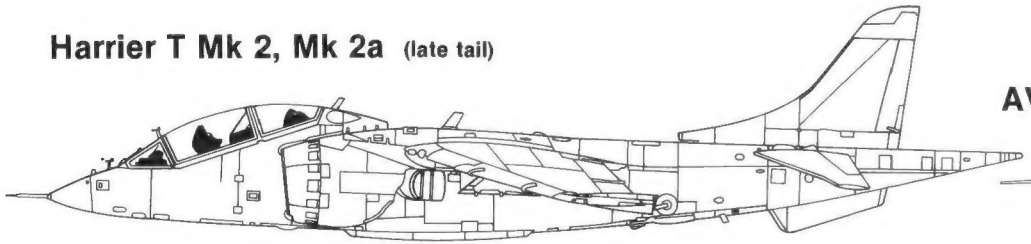
Kestral FGA Mk 1



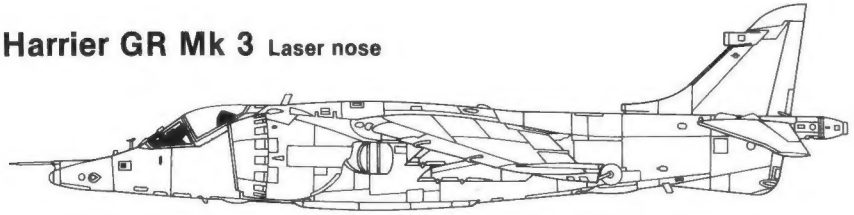
Harrier GR Mk 1, 1a, 3 (early)



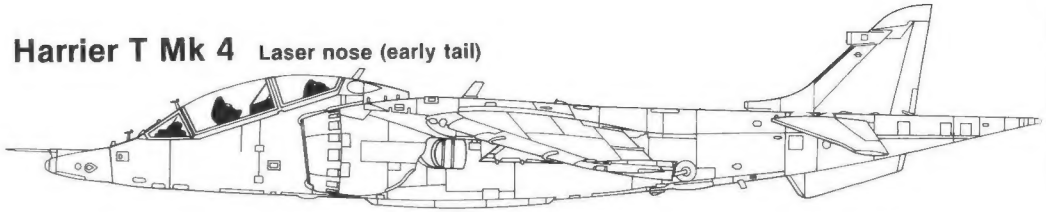
Harrier T Mk 2, Mk 2a (late tail)



Harrier GR Mk 3 Laser nose



Harrier T Mk 4 Laser nose (early tail)



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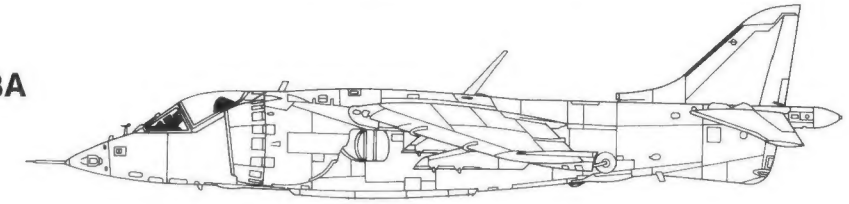
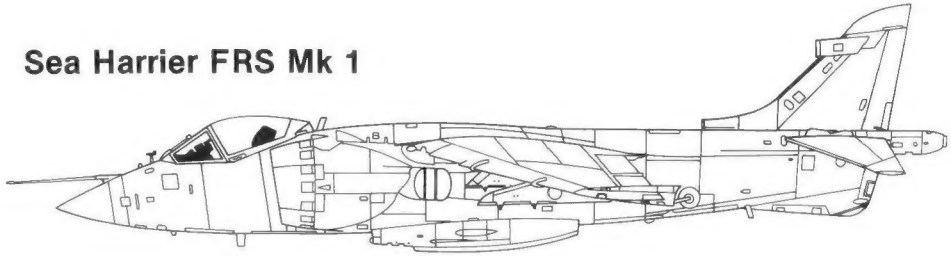


Sea Harrier FRS Mk 1



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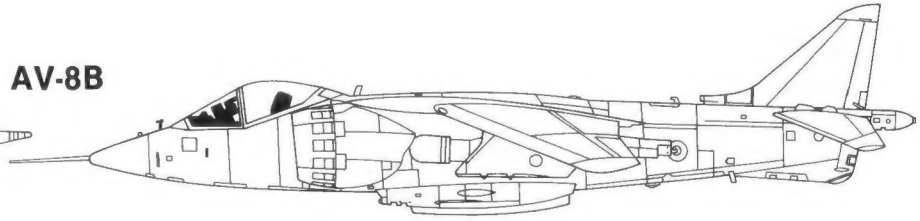

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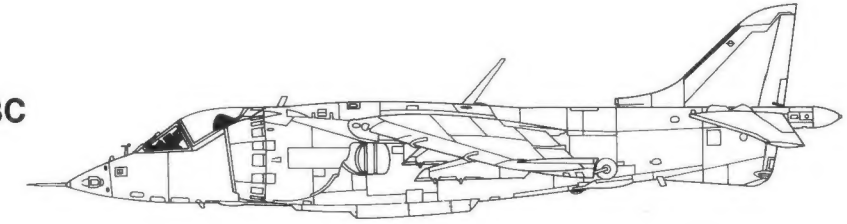


HARRIER GR. MK.1

Production of the single seat Harrier GR (Ground attack Reconnaissance) MK.1 began in 1967 with the first production machine (XV738) flying on 28 December, followed by a second machine during the following February. The GR MK.1 was delivered with the 19,000 lb. st Pegasus 101 engine, featuring a revised combustion system with water injection and a revised double vaned nozzle for vectored thrust. The initial production machines were immediatley pressed into the development program testing operational equipment, navigation/attack systems, underwing stores, in-flight refueling, ceiling, speed, etc. The control system of the Harrier was an especially advanced, powered flying controls system which is able to receive and implement "package signals" from gyroscopes for automatic stabilazation. Any tendency for the aircraft to pitch and roll is sensed by the gyroscope and is automatically corrected through an electro-hydraulic control system of the ailerons and/or the tailplane. The nozzles that control the aircraft during V/STOL are also driven by the power controls working simultaneously with the normal control surfaces. All automatic systems can be over ridden by the pilot.

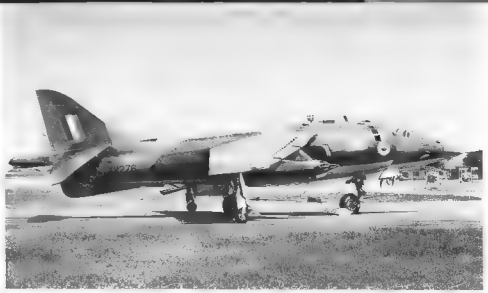
On 1 January 1969 a Harrier Conversion Team (HCT) was formed at RAF Wittering, beginning the process of introducing the new machine into operational service. Initially using a nucleous of four instructors trained at Dunsfold, the team received their first four Harriers in May of 1969, and by September the HCT's strength had risen to fourteen machines (XV744 to XV757). Appropriately, No.1 Squadron, whose motto is Omnibus Princeps (First In All Things), was selected to become the first operational Harrier unit and began turning in their Hawker Hunters for Harrier GR MK.1s during September 1969. At about the same time the HCT was expanded to an Operational Conversion Unit (OCU), officially becoming 233 OCU on 1 October 1970. By January of 1972 four Squadrons had either received their aircraft or were in the process of receiving their aircraft, No.'s 1,3,4, and 20 Squadrons. RAF Wittering, home of the OCU and No.1 Squadron was the main Harrier base, No.3 Squadron was at Wildenrath (Germany), with No.4 and 20 Squadrons being based at Gutersloh (Germany).

Additional improvements were made to production machines, and most of these improvements were retrofitted to service machines as the opportunity or need arose. An inflight refueling probe, Ferranti's NAV/Attack System (INAS), and a Smith's Head-Up Display (HUD). Two under-fuselage mounted Aden 30mm gun pods, with 130 rounds each, gave the Harrier the fire power needed for ground support and attack missions. With these improvements the Harrier became the versatile warrior needed by the RAF.

(Above Right) Five GR.MK.1 Harriers of No.1 Squadron in echelon formation during early 1970. No.1 Squadron was officially formed in 1878 as an Army balloon unit, thirty-four years before the Royal Flying Corps was formed, the oldest flying unit in the world with over 100 years of service. Top surfaces are painted glossy Dark Green/Dark Sea Grey over glossy Light Aircraft Grey under surfaces. (British Aerospace)

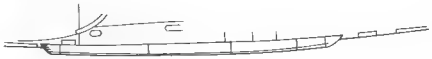
(Right) The Harrier's ability to support ground troops is demonstrated when XV753, fires one of it's four SNEB rocket pods. In addition to the four SNEB pods are two fuselage mounted 30mm Aden gun pods. (British Aerospace)

(Above) XW923, a GR.MK.1, of No.1 Squadron provides a good view of its weapon load. Between the two fuselage mounted Aden gun pods is a 1,000 lb. bomb, four additional 100 lb. bombs are carried on the two outboard pylons while the inboard pylons carry fuel tanks. (No.1 (F) Squadron, RAF)

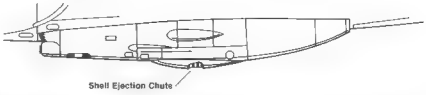


Harrier GR.MK.1, XV 276, carrying rocket pods on the inboard pylons at RAF Abinston, 15 June 1968. The airbrake located just behind the main landing gear door is normally open when the aircraft is at rest. On the belly between the nose wheel door and the main gear door can be seen the strakes usually fitted when the Aden gun pods are not carried. (A. Hafter via Paul D. Stevens)

strake



Aden 30MM gun pod



Participating in flight trials aboard HMS Eagle during March 1970, XV281 rises to the flight deck to take it's place among the Buccaneers and Sea Vixens. The airplane is marked with a large White E (Eagle), a small White ■ on the rudder, and a White four legged animal on the air intake behind the roundel. (British Aerospace)

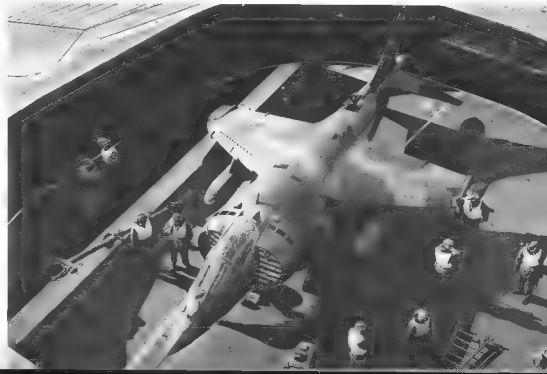
Harrier GR MK.1A

The GR MK.1A designation was applied to aircraft retrofitted with the new uprated Pegasus 102 engine of 20,500 lbs. thrust which was the intended powerplant of GR MK.1. Identical in all other respects to the MK.1 the new GR MK.1A was first seen by the public at the Japanese International Air Show in Nagoya in October 1971. Squadron introduction began the same year, with squadron conversion to the GR MK.1A being completed by the end of 1974.

The huge air intakes required to handle the volume of air used by the Pegasus engine during V/STOL creates drag that prevents the Harrier from flying at supersonic speeds. The levered nose wheel is fully castered and steerable. The outrigger wheels provide the Harrier with possibly the best rough ground handling characteristics in the flying world. (British Aerospace)

A No.3 Squadron GR 3 operating from a dispersal site in Germany. Initially No.3 Squadron used number codes but after two months the squadron began using letter codes, conforming to the practice of the other Harrier units. To make the Harrier less conspicuous matt varnish was sprayed over the glossy factory finish and B type roundels (Red/Blue only) were applied to the upper wings and intakes during November of 1970, the White in the fin flashes was also dropped at the same time. (Ministry of Defense)

A GR 3 from No.1 Squadron descends on the forward elevator of the HMS Ark Royal during sea trials during September of 1975. Exposed at the base of the fin is the Ram Air Turbine. When the matt varnish top coat was found to be a poor substitute for matt paint, the Harriers began receiving a new coat of matt polyurethane colors during overhauls. (HMS Ark Royal)

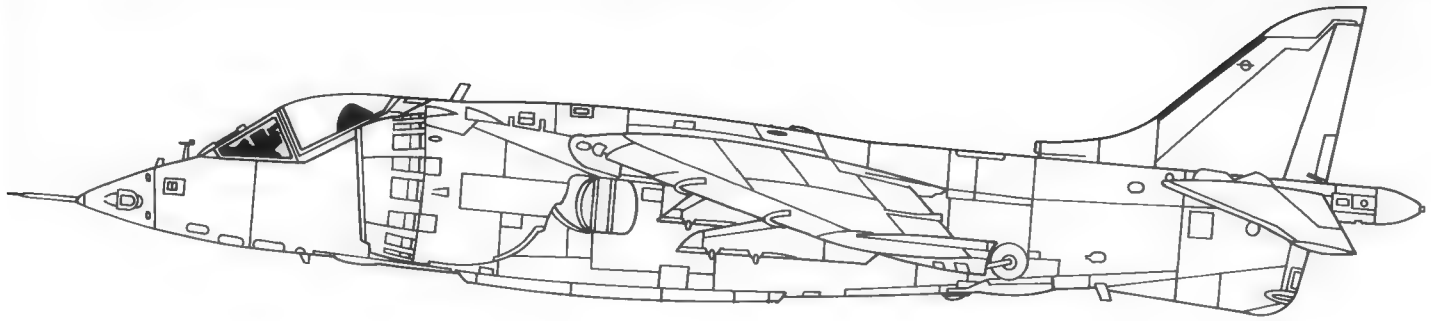


GR MK.1s of No.20 Squadron carrying out strike attacks from "hides" along a German farm road during excercise "GRIMM CHARADE". (MOD Photo)

While in Belize the Harriers of No.1 Squadron obtained names like Beech Buggy (XV778), Rotate One (XV772), and Hot to Trot (XV787) which also sported a shark mouth. 233 OCU later took over this duty and in 1980 the Belize based Harriers were designated No. 1417 Flight and adopted a White sailfish flanked by Red and Blue segmented rectangles as an emblem. (Capt. Chuck deVlaming)

When the British Central American Colony of Belize was threatened with invasion by Guatemala, a detachment of Harriers from No.1 Squadron was sent to the Belize City Airport as a show of force. Beech Buggy was flown by F/O Mike Beech of Flight D. (Capt. Chuck deVlaming)

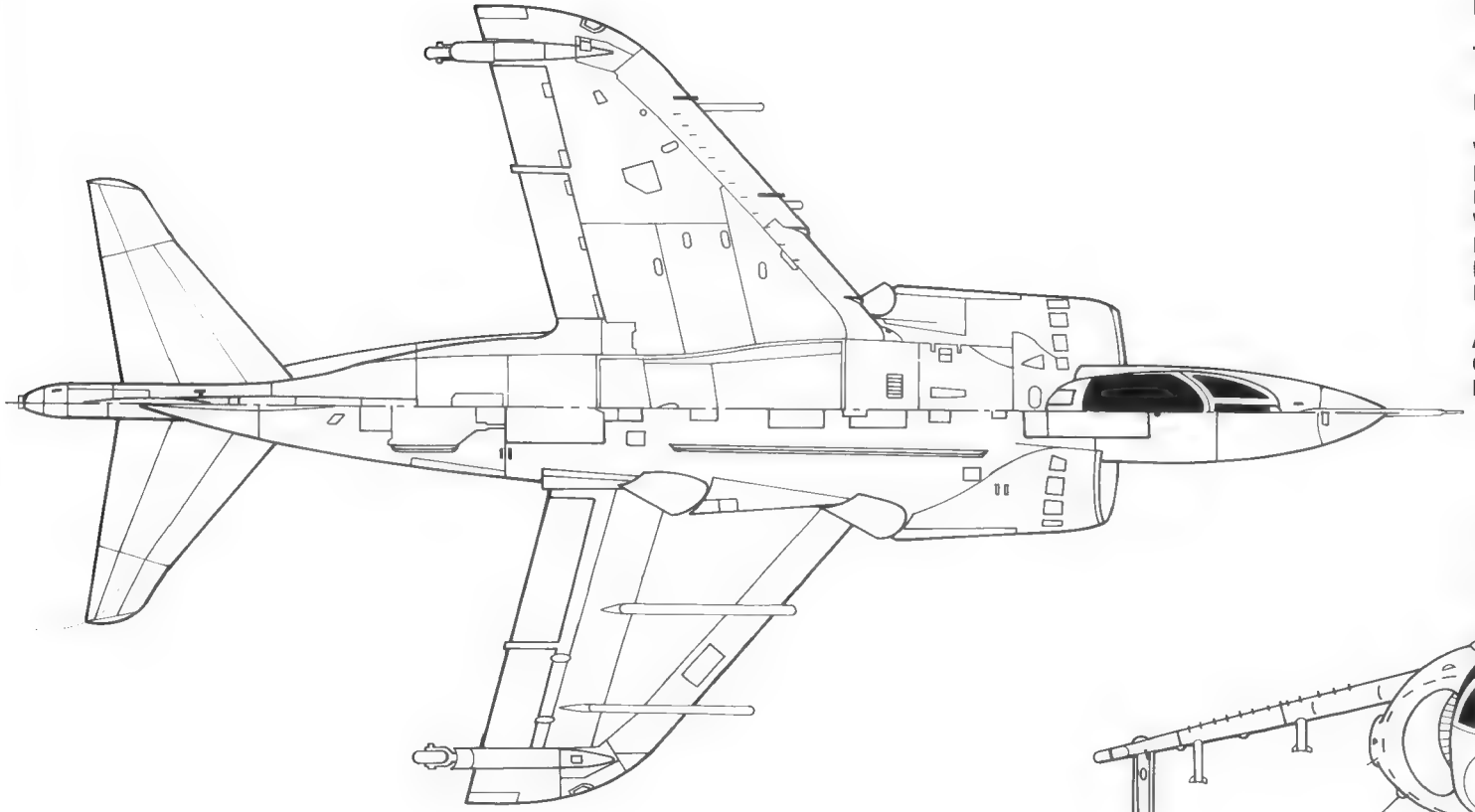
Harrier GR MK 1

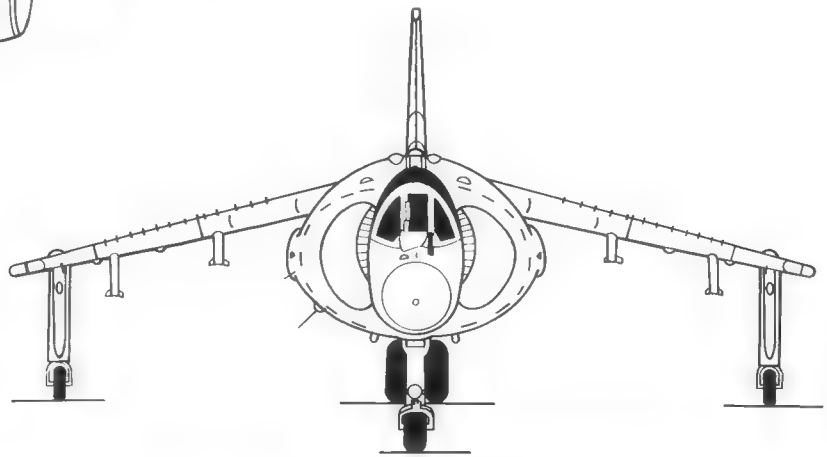


Specifications

GR Mk.1

Manufacturer:	British Aerospace (Hawker Siddeley)
Type:	Single seat, ground attack reconnaissance aircraft
Engine:	Rolls Royce Pegasus 101, 19,000 lbs. st. thrust
Wingspan:	25ft.3½in.
Length:	46ft 4in.
Height:	10ft 9in.
Weight:	12,000lb.
Loaded Weight:	22,000lb.
Max Speed:	0.96 Mach
Range:	1,400 plus nautical miles (ferry range)
Armament:	two 30mm Aden guns
Ordnance:	5,020 lbs.
Mission Radius:	575 miles





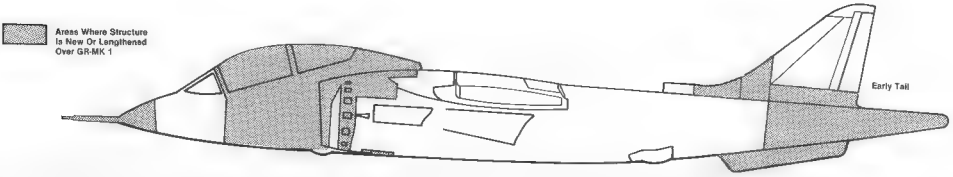
Harrier T MK.2
TWO SEATED TRAINER

During the redesign effort of turning the P.1127 Kestrel into the Harrier, Hawker was directed to carry out a feasibility study on producing a two seated trainer version of the Kestrel. The completed study was viewed favorably by the Ministry of Defense and work on the two seated version was begun in 1967. John H. Fozard, Hawker chief designer, characterized the project as "another make-it-better-but-don't -change-many-drawings-and-don't-spend-much-money." The aircraft was to be a two seated machine with performance characteristics matching as closely as possible the single seat machine, making transition to the single seater quick and easy and also making deployment of the two seated aircraft into the frontline combat role with as little performance penalty as possible.

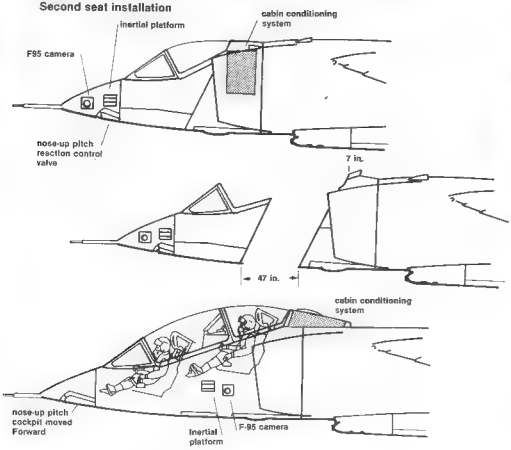
Under the designation Harrier T MK.2, the basic airframe of the two seater remained essentially the same as the single seated machine, however, the fuselage forward of the air intake was lengthened by 47 inches to accomodate the rear cockpit and its additional flight controls. The second seat was elavated 11 inches to provide an unobstructed forward vision for the instructer, thus creating a stepped tandem seating arrangement. New side opening canopies replaced the single rearward sliding canopy, the inertial platform and F95 camera were relocated from the side of the nose cone to a position on the side of the fuselage below the rear cockpit. To balance the destabilizing effect of the nose extension, the fin was increased 33 inches in length and 11 inches in height. The ventral fin was enlarged and totally reconfigured in shape. The tail cone was redesigned and lengthened, extending 81.5 inches from the base of the rudder and was filled with ballast to counteract the additional weight of the new nose section. As with its single seat counterpart, the T MK.2 was powered by a 19,000 lb. st Pegasus MK 101 engine.

Flying for the first time (XW174) in April 1969, the two seated Harrier T MK.2 trainer entered service just sixteen months after the single seater. Naturally the first squadron to receive the T MK.2 was No. 233 OCU at RAF Wittering during July 1970, with the operational squadrons later receiving one each. After entering service, however, the increased forward area caused 'weathercocking' which was solved by increasing the fin and rudder height by an additional 18 inches. XW272 was the first production machine delivered with the new tail in August 1971. It was several years before all earlier T MK.2 aircraft were retrofitted with the taller tail.

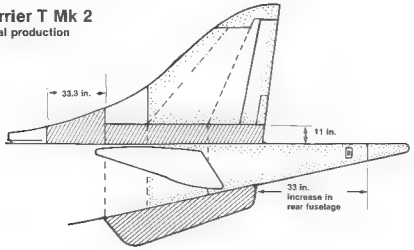
An early T MK.2 trainer with the initial production fin which was 11 inches taller than the fin on the single seated Harrier. Later production T MK.2s had a further 18 inches added to the height of fin which also changed its shape. All trainers were eventually retrofitted with this 18 inch increase, but not immediately. The F95 camera opening was moved from the nose cone to below the rear cockpit just in front of the air intake. (British Aerospace)



Harrier T Mk 2
Second seat installation



Harrier T Mk 2
initial production Tail

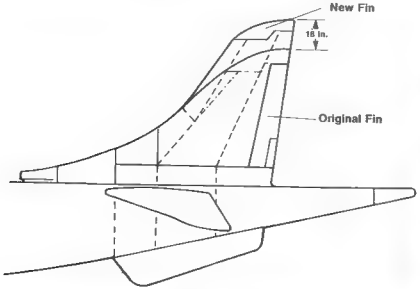


The two seated Harrier has a full windscreen for the second cockpit. Powered by the new 21,500 lb. st Pegasus MK 103 engine, the Harrier T MK.4 was indistinguishable from the earlier T MK.2 and T MK.2A aircraft. This trainer, belonging to No.233 OCU at RAF Wittering mounts the Aden cannon pod instead of the strakes usually found on training aircraft. This machine also carries the early production tail. (Ministry of Defense)

This slowly descending T MK.2 Harrier provides us with an excellent view of the underside. The tail extension is long enough that the normal distortion found in a camera lens optically bends it to the port side of the picture. The machine carries strakes fitted to the belly instead of the 30MM Aden gun pods. Just above the huge opening in the engine air intake can be seen the port cockpit conditioning air scoop. (British Aerospace)

Harrier T MK.2A

Under the designation T MK.2A, the two seated trainer version was also fitted with the uprated Pegasus MK.102 engine, and like the GR MK.1A no external changes were made.



(Above) Sea trials of the T MK.2 were carried out during February 1977 aboard HMS Hermes. (HMS Hermes)

(Left) As a sales aid Hawker funded the production of a two seated export demonstrator under the export designation Harrier T 52 and carrying the civil registration G-VTOL. Powered by a Pegasus MK 103, the machine was initially finished in a gaudy Red, White and Blue color scheme. The machine flew for the first time on 16 September, 1971. Basically a T MK.4, the aircraft was repainted in a desert scheme of light Brown and dark Brown when seen at the Farnborough Air Show in September of 1978. (L. Peacock)

HARRIER GR MK.3

While service introduction of the uprated Pegasus MK.102 powerplant went extremely well, early development problems caused the more powerful 21,000 lb. st MK.103 engine to be viewed with a certain amount of apprehension. The transonic blading of the new fan however, permitted a much better compressor rematching, and the handling characteristics proved to be far superior to it's predecessor. Besides an increase in performance, engineering and further development had increased engine reliability and the MK.103's service life had been extended from 200 hours to over 600 hours.

Regardless, other than ordering twelve Pegasus 103 powered Harrier GR MK.3s to meet attrition demands, the RAF deferred the new engines to production of the US Marine Corps AV-8A Harrier, preferring to slowly convert their existing Pegasus 102 powered GR MK.1As into the more powerful GR MK.3 configuration. Updating the RAF's Harrier force to GR MK.3 standards was nearing completion in late 1975. Externally, the MK.1, MK.1A and MK.3 were essentially the same, however, this was to change dramatically.

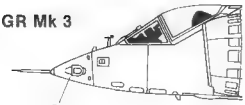
During the early 1970's the RAF embarked on a major avionics program to develop and integrate a laser range finder into the FE 541 system. The new Ferranti Laser Ranging and Marked Target Seeking (LRMTS) equipment was housed in a new nose cone of very distinctive and conspicuous shape, radically altering the profile of the GR MK.3. Using the new LRMTS/FE 541 system bombing accuracy improved considerably. Another addition to the Harrier GR MK.3 avionics was a Passive Warning Radar (PWR) system with antennas housed in the fin (forward looking) and tail cone (rearward looking). Incoming foreign radar signals can be identified as to direction, type and stength, allowing the pilot to take evasive action. The fin mounted antenna added approximately 8 inches in height to the fin. The RAF began updating the GR MK.3 with the new LRMTS and PWR systems beginning in 1976. The first GR MK.3 fitted with the new nose cone and tail warning devices, (XZ128) was delivered in March of 1976 to No.1 Squadron.

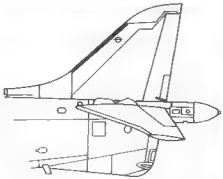
By 1977 twenty-four Harriers had been lost in crashes, and despite orders to Hawker for replacement aircraft, it was found that the number of Harriers available was insufficient to support the OCU and four squadrons. Rather than purchase additional aircraft it was decided to convert No.20 Squadron to Jaguar MK.1s, dividing its Harriers between the remaining four units.

(Above Right) Two Harriers from No.3 Squadron illustrate the external changes made in the Harrier GR MK.3. with the addition of avionics. The GR 3 in the foregound has been retro-fitted with the new Laser nose and Passive Warning Radar (PWR) aerials mounted in the fin and tail cone. The Laser nosed machine carries a gun pod on the lower fuselage, while the machine in the background is fitted with the strakes normally carried when the Aden gun pods are not. (British Aerospace)

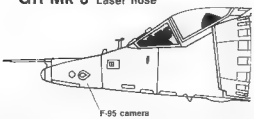
(Right) XV 738 just after take-off. The 30MM guns are plugged to prevent dirt or other foreign matter from entering the barrel. The location of the gun, being behind the air intake prevents gasses emitted during firing from entering the engine air, is ideal. (Crown Copyright, RAF Germany)

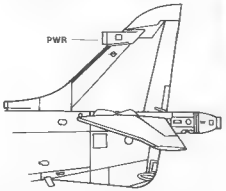
GR Mk 3





GR Mk 3 Laser nose





(Above) The PWR system considerably increases the Harrier's survivability in hostile airspace. The fin was increased in height by 8 inches to accommodate installation of the fin aerial, which sweeps 180 degrees forward. The tail cone aerial sweeps 180 degrees to the rear. Belonging to No.3 Squadron the W on the tail is in Yellow. (Capt. Chuck deVlaming)

(Upper Left) The Black tip on the nose cone of the GR 3 is a protective 'eyelid' for the laser unit. The teardrop glass on the side of the nose is the cover for a F95 70MM oblique camera which can be supplemented with a five camera belly pod. This No.3 Squadron Harrier carries the later style Red and Grey Cockatrice on a White disc set in bars of Mid-Green outlined in Yellow. (Capt. Chuck deVlaming)

This Laser Nosed GR MK.3, stripped of all markings, lands on board the Hermes after a mission over the Falkland Islands. Note the empty outer pylons. (Wide World Photos)

(Above) A GR MK.3 is silouted against the sky as it comes down for a visit at Ramstein Air Base, Germany. (Andy Mutzig)

(Upper Left) Three Laser nosed GR 3 Harriers from No.3 Squadron during a training mission. The dirty gun pods and undersides are a result of a recent trip to the firing range. While the outrigger wheels provide excellent unprepared ground capability, they do cause a problem of drag, even when tucked away in the wing fairing. Subsonically this is not a major problem, but as the speed of the Harrier increases, so will the problem of drag. (British Aerospace)

(Left) With paint worn off of the laser nose protective eyelid and fuel tanks, this GR 3 of No.3 Squadron has its intakes covered with padded canvas covers. Sembach A.B., Germany, 1978. (Andy Mutzig)

A YANK IN THE RAF

A modern day Yank in the RAF, Capt. Chuck deVlaming, a USAF exchange pilot flying Harriers with No.1 Squadron, provides some insight into RAF Harrier operations. Before deVlaming entered the RAF exchange program, he had already accumulated over 2,000 hours in single seat, single engine jet fighters, and had two combat tours in South East Asia, flying F-105D Thunderchiefs in his first tour, and A-7D Corsair IIs in his second.

My experience with the RAF includes nine months of lead-in training, during which, I received Orientation Training in the Jet Provost, Tactical Training in the Hunter, and an introduction to hovering in the Westland helicopter before going on to the Harrier. After completing the six month Harrier Training Course I was assigned to No.1 (F) Squadron. The Harrier is a very unique aircraft having the qualities and performance of both a helicopter and a high performance jet fighter. Without question the Harrier is unequalled in it's VISTOL mode of operation. During war when conventional fighters are grounded because of damaged runways, the Harrier can fight on!

The Harrier is subsonic not because of it's thrust to weight ratio, which is greater than 1:1, but because of the drag created by its huge air intakes. The intakes had to be designed to accommodate the mammoth volume of air required by the engine during VISTOL operations. The Harrier has a high wing loading which results in degraded turning performance; a wing design which would have resulted in greater turning capability, would have created more weight and drag, and would have reduced speed and VISTOL capability.

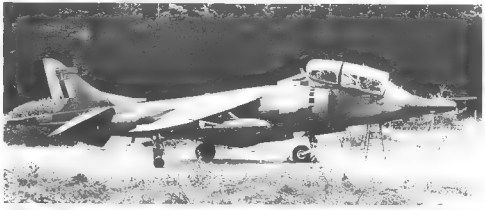
The tactics and operating concepts employed by the RAF do much to enhance the Harrier's unique capabilities, the Harrier is designed to operate close to the 'battlefield' from hidden locations (hides), using roads, or if necessary grass strips for take-offs and landings. The Harrier is designed to fly a mission an hour with the pilot remaining in the cockpit between sorties and flying up to six missions per day. These capabilities and operating tactics reduce the need for high speed, long endurance and a large war load. The Harrier is operated at very low altitudes where the threat of enemy air attack is reduced. One must keep in mind that the Harrier is optimised for Ground Attack, not Air to Air combat, thus speed and turning capability are not as essential as they are for an Air to Air fighter. In short, the Harrier can operate any place, anytime; it is one of the most flexible and responsive Ground Attack Fighters in the world.

Many people have asked me what it is like to fly the Harrier and to be a Yank in the RAF. My answer is always the same. MAGIC! Because for me it is a boyhood dream that really did come true. The thrill of rising vertically on a column of thrust from a wooded site is an exhilarating experience...whether it's the first time or the hundredth!

A Modern Yank in the RAF, Capt. Chuck deVlaming, USAF, poses along side his Harrier GR MK.3 of No.1 (F) Squadron. Painted in full wrap around camaflage, the machine carries the No.1 Squadron insignia, in Red, White and Yellow, and is painted on both sides of the nose. (Capt. Chuck deVlaming)

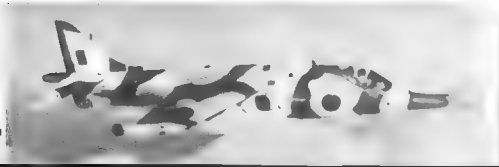
Harrier T MK.4

The two seated version of the GR MK.3 was the 21,500 lb. st Pegasus Mk.103 powered T MK.4. There was nothing externally to differentiate between the two seated T MK.2, T MK.2A and T MK.4 until the Laser nose and PWR were added to the T MK.4, however these advanced avionics have seldom been fitted to the T MK.4 trainer.



One of the very few T MK.4 trainers that was fitted with the Laser Nose and tail mounted PWR. This machine is also one of the few trainers serving with an operational squadron, in this case No.1 Squadron seen during an exercise in Germany. The wrap around camouflage extends over the lower fuselage surfaces but not the lower surfaces of the wing or tail plane. (Kurt Thomsen)

Part of NATO's ACE MOBILE FORCE, No. 1 Squadron deploys every year to northern Norway to participate in exercise COLD WINTER. The Harriers are whitewashed with a water soluble white paint covering the complete under surfaces and the green areas of the upper surfaces. Note the underwing stores are also all white. (Capt. Chuck deVlaming)



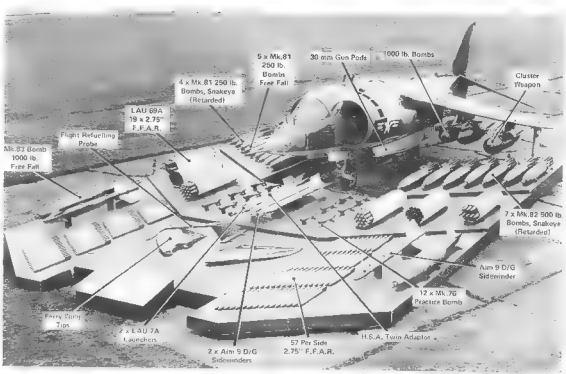
No.3 Squadron also received a Laser Nosed T MK.4 trainer, serialed XZ145. (Kurt Thomsen)

UNITED STATES MARINE CORPS HARRIERS

At the 1968 Farnborough Air Show, two khaki clad United States Marine Corps flying officers, Lt. Colonel Bud Baker and Colonel Thomas Miller, walked into the Hawker Siddely exhibition Chalet. Announcing that they were in England to fly the Harrier the two Marines asked the astonished Hawker Officials for "...the pilot's notes, please." However, within two weeks of the show and after a crash conversion course, both were in the air, testing Harriers to see if this little ground attack V/STOL would be of any use to the Marine Corps. During one flight Baker and Miller were engaged in mock air combat, Miller was in the lead with Baker closing in hot on his tail. Suddenly, Miller pulled the nozzle selection into the breaking position. "It was almost like making an arrested landing", Colonel Miller recalls of the Harrier that day, "it just sort of squatted!" Baker's Harrier shot over Miller, in split seconds the hunted had become the hunter. Miller and Baker knew they had found a plane for the Corps. The two colonels returned to Washington, turning in to Marine Corps Chief of Staff, General K. McCutchen, an extremely enthusiastic report.

Within three months a United States Navy test pilot team was in England conducting a preliminary evaluation of the Harrier and five months later the Marines received approval to purchase 12 Harriers immediately, and a declared intent to purchase 110 more by the mid 1970s. However, during Congressional hearings preceding purchase approval, Congress made it abundantly clear that funding for future purchases would be approved only if a substantial portion of the production was done in the United States. As a result, a 15 year license agreement was signed between Hawker Siddely and McDonnel-Douglas for the exclusive manufacture and sale of the Harrier and it's derivatives in the USA. The agreement called for the mutual exchange of date and drawings of vectored V/STOL thrust based on the Harrier during the fifteen year contract. In the event, the United States Congress, during the Fiscal Year 1971 (FY71) budget debates, refused to fund the additional costs of moving production to the States and as the costs increased relative to the decreasing number of aircraft to be built, moving production to the United States was less and less attractive. As John W. Fozard, Chief Designer of the Harrier from 1965, points out, "To our astonishment in the UK, against all odds and despite the advice and counsels we had been given in 1969, the total USMC fleet procurement of 110 Harriers were built in England, the last aircraft being delivered in 1976."

This Harrier GR MK.1, serialed XV742, was painted in USMC markings while undergoing evaluation and conducting demonstrations by the Marines during 1968. The aircraft number is Black 12, the tail codes are WF and the bomb load is all RAF. (British Aerospace)



XV742 masquerading as a USMC Harrier for a weapons load display. Note the wing tip extension used for ferrying and the bolt on in-flight refueling probe. (British Aerospace)

THE HARRIER GR MK.3 BECOMES THE AV-8A

Under the procurement restrictions imposed upon the USMC purchase of the Harrier, the machine was bought as an "in production, off the shelf" aircraft which required little or no change in order to go into service. Designated AV-8A Harrier by the Marines, modifications to the Harrier GR MK.3 were few: a weight-on-wheel armament switch, take-off and landing checklist in the cockpit, USN radio equipment with a tactical VHF antenna mounted on the mid-upper fuselage, and permenantly attached outboard wing pylons for Sidewinder missiles. Flight testing of all USN ordnance was conducted in the UK and found to be satisfactory.

Ordered with the MK.103 engine, the first ten AV-8As were in fact delivered (beginning in February 1971) with the less powerful MK.102. However, these machines were subsequently retrofitted with the MK.103 engine. Requiring a simple and more easily maintained navigational/weapons system, the FE 541 inertial nav-attack system was replaced by the simpler I/WAC (Interface/Weapon Aiming Computer) known as the Baseline System. From the 60th production aircraft, the AV-8A was delivered with a redesigned cockpit, and from the 90th production machine it featured a US manufactured Stencil S111S-3 ejection seat replacing the standard British Martin Baker seat.

The first USMC Harrier Squadron, VMA-513 'Flying Nightmares' (WF tail code), was formed at Beaufort, South Carolina under the command of Lt. Colonel Bud Baker during April of 1971. In December of 1972 VMA-542 (WH) 'Tigers' was added, and in October 1973 a third AV-8A Harrier squadron, VMA-231 (CG) 'Ace of Spades' was formed, followed by the training squadron, VMAT-203 (KD) during 1975.

The Marine Corps has found the Harrier to be the ideal close support ground attack fighter and the fact that their purchase was slowly spread over five years says more about the financial string pullers than about corps enthusiasm for their Harrier. Given the Harrier's unique ability to operate from the deck of assault ships as well as its ability to stay close to the ground forces by operating from just behind the front lines or from rudimentary bases within a beachhead, the AV-8A looks like it will be part of the Marine inventory for some time to come. The US Congress might have been prudent to have funded moving Harrier production to the States as they originally outlined.

Always innovative the Marine Corps has written a new page in the air-to-air combat tactics manual by using the vectored thrust, not just for vertical take-off and landings but also during forward flight as well. Termed Vectoring In Forward Flight (VIFF) or VIFFing as the pilots refer to it, dates back to the first flight trials by Miller and Baker when Miller hit the nozzle selector, causing Baker to overshoot him. VIFFing provides an extraordinary rate of deceleration during level flight, and turning the nozzles downward during a rolling turn provides a very tight turn. An enemy fighter would have a very difficult time getting a Harrier into its sunsights, and at the same time an enemy would be running a very grave risk of finding a Harrier that was being chased, suddenly firing at him from behind. The Argentine Air Force found out about VIFFing over the Falkland Islands during the spring and summer of 1982.

(Top) The first squadron to be equipped with the new AV-8A was VMA-513, 'The Flying Nightmares'. This machine of VMA-513's detachment A, carries the WF tail codes and nose numbers in medium Blue, the rudder is dark Blue with White stars. (Jim Sullivan)

(Middle) The 'Tigers' of VMA-542, the second Marine squadron to receive the Harrier, carried colorful Black and Yellow rudder stripes until 1978 when USMC requirements stopped this practice. The squadron emblem, a tiger's head on a White disc is carried on the tail just above the WF tail codes. (Don Spering)

(Right) The third squadron to receive the AV-8A was VMA-231 'Ace of Spades'. This machine has been fitted with a bolt on refueling probe. The dive brake is in the open position which is the normal position when the Harrier is at rest. (Don Spering)

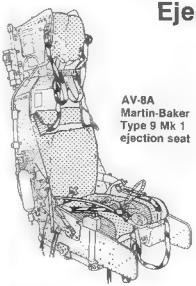
(Above) While USMC Harriers were regularly deployed on assault ships and had conducted trials on carriers, VMA-231 did a nine month tour on board the USS Franklin D. Roosevelt during 1975-76. The 'Spades' temporarily adopted the NM tail codes of Carrier Air Wing 19 (CVW-19) while on the Roosevelt. (U.S.Navy)

(Above Right) Ordnancemen arm 607 of VMA-231 on the flight deck of the Roosevelt. While on the carrier tour all fourteen of VMA-231's Harriers were equipped with refueling probes. (PH3 G. Haas/USN)

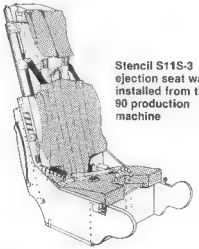
(Right) VMA-231 flight deck crew hang a snakeye bomb on an inboard pylon. The underside of the wing appears to be very glossy. (PHC Wade Davis/USN)

Back home at Cherry Point some of the VMA-231 aircraft still carry the NM codes of the Roosevelt, but all have had the refueling probes removed. (Jim Sullivan)

Ejection Seats

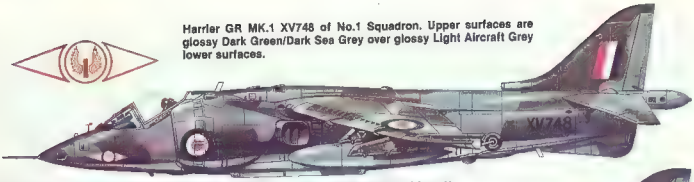


AV-8A Martin-Baker Type 9 Mk 1 ejection seat



Stencil S11S-3 ejection seat was installed from the 90 production machine

(Left) Deck towing the very stable AV-8A proved to be an easy task, however the outrigger wheels sometimes got in the way. Note how the refueling probe partially covers the third blow-in door. Between September 1976 and May 1977 VMA-231 Harriers amassed over 2000 hours of flying time, nearly 400 of it at night. (PH3 G. Haas/USN)

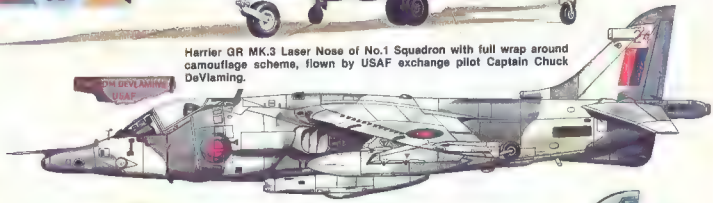


Harrier GR MK.1 XV748 of No.1 Squadron. Upper surfaces are glossy Dark Green/Dark Sea Grey over glossy Light Aircraft Grey lower surfaces.

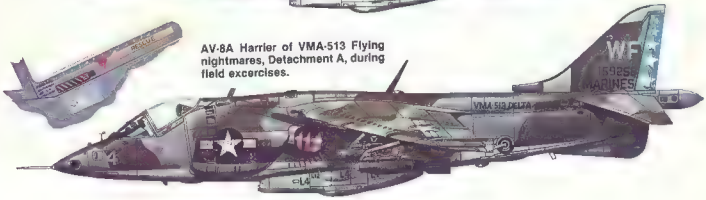
Harrier GR MK.1 of No.20 Squadron. The glossy surfaces have been oversprayed with matt varnish. Type B roundels (Red and Blue only) have replaced older style roundels on the fuselage and upper wings, fin flashes also have had the white deleted.

Harrier GR MK.1, "Beech Buggy" of No.1 Squedron at Belize City Airport, Belize, Central America. Flown by F/O Mike Beech, the aircraft has been repainted in the new matt polyurethane.

Harrier T MK.4 XW925 of No.233 OCU at RAF Wittering.



Harrier GR MK.3 Laser Nose of No.1 Squadron with full wrap around camouflage scheme, flown by USAF exchange pilot Captain Chuck DeVlaming.



AV-8A Harrier of VMA-513 Flying nightmares, Detachment A, during field excercises.

White 25, an AV-8A of VMA-542, flown by Capt. P. Owen, carries four Skyhawk kills acquired during training.

AV-8A of VMA-542 Flying Tigers in the new all Black subdued markings.

TAV-8A of VMAT-203 Training Squadron.

VA.1 Matador of 8. Escuadrilla, Spanish Navy at Rota Spain.

Sea Harrier FRS MK.1 of 800 Squadron (HMS Invincible). Extra Dark Sea Grey upper surfaces over White lower surfaces.

Sea Harrier FRS MK.1 of 899 Squadron from HMS Hermes during the Falklands fighting.

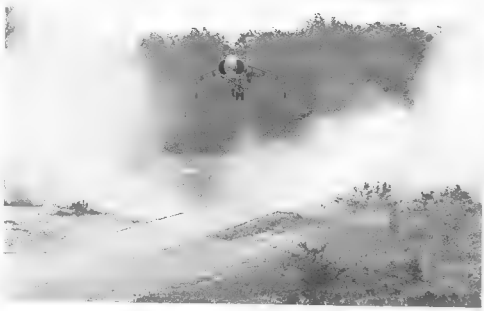
VMAT-203, the Harrier training squadron was formed in 1975. Tail codes, VMAT legend, and aircraft number on the nose are in White. White 12, one of the single seat Harriers assigned to VMAT-203, carries fuselage strakes instead of the 30MM Aden gun pod. Because of funding uncertainty the training squadron was the last squadron to be formed. (Author)

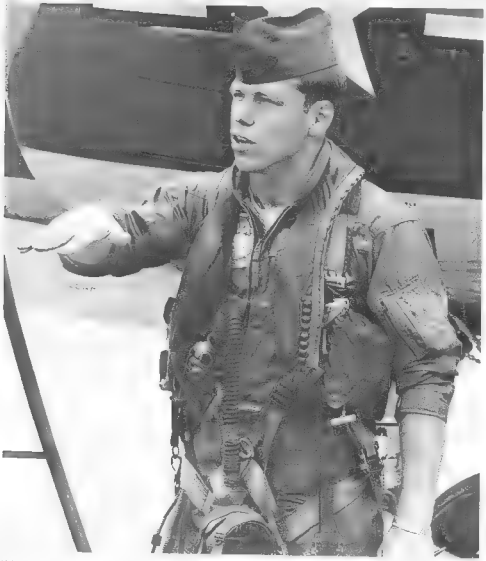
Deployed at a simulated tactical position close to the front lines, 4/WF of VMA-513 Detachment A awaits orders to scramble in support of ground troops in contact with enemy forces. (Robert D. Ward)

Barely off the ground, 4/WF begins its transition to horizontal flight. (Robert D. Ward)

Receiving a scramble, 4/WF taxies to position for take off. Other aircraft of Detachment A are dispersed in hides under heavy camouflage along the two lane country road which serves as a runway. (Robert D. Ward)

Armed with four 500 lb. MK 82 Snakeye bombs and two 30MM Aden cannon pods, 4/WF begins its STO. (Robert D. Ward)





(Above) Like pilots the world over, the Harrier pilot talks through the post mission debriefing with his hands. (Robert D. Ward)

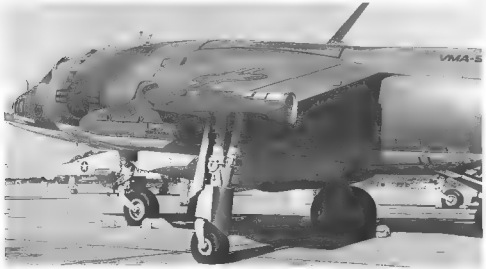
(Above Left) Approaching the target at tree top height, the pilot executes a "pop-up" maneuver. Rolling the plane on to its back at the top of the POP-UP, the pilot visually acquires the target and aligns the aircraft for the drop. The pilot then completes the roll to the normal altitude and the on board bombing computer releases the ordnance, in this case, snakeye bombs (released in the high drag mode). No second pass is made. (Robert D. Ward)

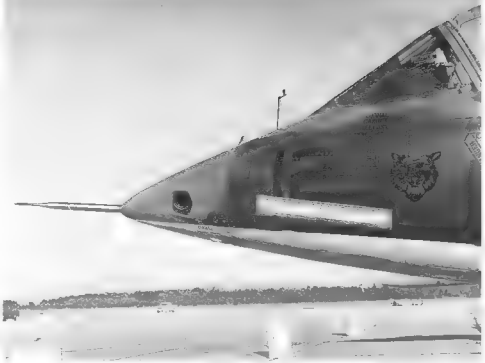
(Left) Minutes later, after releasing its ordnance on enemy positions, 4/WF lands to be refueled and rearmed. The Harrier is designed to carry out a mission an hour and up to six missions per day. (Robert D. Ward)

This pair of AV-8As from VMA-231 carry the new all Black low visibility markings, even the unit insignia is in Black. Just below the Harriers front nozzle can be seen one of the Harrier's blade antennas.(Author)

(Below Right) The AV-8A is equipped with a weight-on-wheels armaments lock that prevents the guns from being accidentally fired when the aircraft is on the ground. (Author)

(Below) The outrigger landing gear have telescopic oleo struts whose lowering and retraction is accomplished by hydraulic jacks with mechanical locks. These outriggers provide an unparalleled degree of stability. This is especially important to the Harrier given its mission of operating from unimproved ground. (Author)





(Left) The formation strip lights are a Marine Corps addition to the Harrier. Immediately in front of the cockpit is the weather vane yawl found on all Harriers. Belonging to VMA-542, this machine carries the revised low visibility squadron emblem, a tiger's head in Black and Gray. (Author)

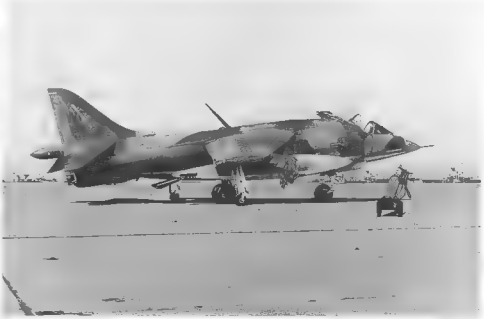
(Below Left) The AV-8A has also had the formation strip lights added to the fin. Note the aircraft number painted on the inside of the air brake. (Author)

(Below) The front covering of the outrigger locks into place, becoming a lower fairing when the outrigger is retracted. (Author)

The AV-8A cockpit was completely redesigned from delivery of the 60th production machine. All instrument panels, consoles, sides and floor are finished in light matt Grey epoxy paint. Instruments are Black with White letters and pointers, emergency controls are striped in Black and Yellow. (McDonnell Douglas)

A pair of AV-8As, carrying long range fuel tanks, are being refueled by a KC-130R Hercules. (Lockheed via John Fletcher)

06, a VMA-513 Harrier mounting long range drop tanks, is parked on the ramp at NAS Alameda. (Tom Chee)



Operating close to the front from 'hides' such as these at Boque Field, SC, Harrier pilots learn to provide quick response, fast turn around to support ground troops. (Author)

(Above and Left) White 25 flown by Capt. P. Owen of VMA-542 Flying Tigers carries four A-4 Skyhawk kill markings acquired during training. British pilots have been just as successful against Argentine Skyhawks. (Gary Emory)

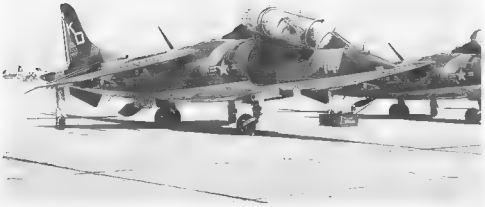
TAV-8A TRAINER

Fearing that Congress might change its mind and cut off funding before they could take delivery on all 114 ordered Harriers, the USMC delayed ordering the two seated trainer until Fiscal Year 1973. Under the designation TAV-8A, eight two seaters were ordered, bringing the aggregate total of Harriers to 110 aircraft (not 114 aircraft as originally declared). The TAV-8A two seated trainer bears the same relationship to the AV-8A that its RAF counterparts, the GR MK.3 and T MK.4 bear to each other. However in addition, the Marine two seater also is capable of operating in the Tactical Air Commander (Airborne) role. A full range of combat radio equipment from Tac VHF to UHF is fitted which are capable of seperate and independant use from the rear seat. Delivered during the summer of 1976, the first TAV-8A trainer became operational with VMA(T)-203 at Cherry Point during August of 1976. Marine squadrons originally carried 20 Harriers on strength, however some 40 major accidents have reduced this strength to 15 fighters per squadron. The addition of the two seated TAV-8A and stiffer pilot selection has reduced the Marine Corps' attrition rate considerably.

(Above Right) BuAer No. 159378, the first of the eight ordered TAV-8A two seated trainers during a test flight at Dunsfold prior to USMC delivery during the summer of 1976. All USMC two seated aircraft were delivered with the late production fin. (British Aerospace)

(Below Right) The rear cockpit, fully independant of the front seat controls, carries additional combat radio equipment allowing it to function in the Tactical Air Commander (airborne) role. Note the swing down step. (Author)

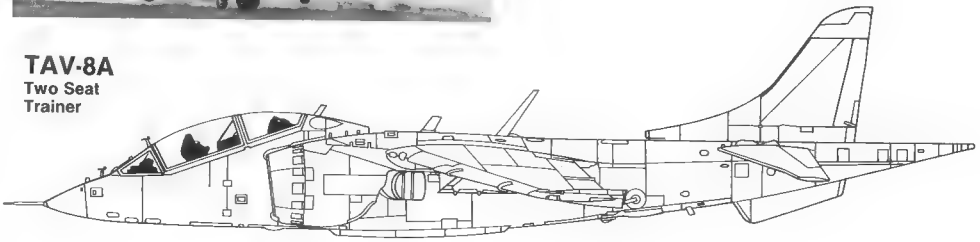
(Below) The TAV-8As assigned to VMAT-203 at MCAS Cherry Point, carry rudder stripes of Red, White and Blue, left to right. Note the stop cables that prevent the side opening canopies from being opened to far. (Jim Sullivan)



(Above) The eight TAV-8 Harriers were assigned to VMA(T)-203, based at MCAS Cherry Point, for Harrier conversion training. The aircraft number, fifteen, is repeated on the tail just above the rudder. (Richard D. Ward)

(Left) Aircraft No.1 of VMAT-203 is just about to touch down at Cherry Point. This two seater has had the formation strip lights added, but like all trainers, still carries high visibility markings. (USMC)

TAV-8A
Two Seat Trainer

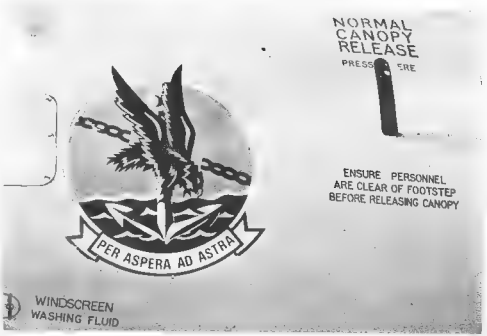


SPANISH VA.1 MATADOR

The third air arm to operationally equip with the Harrier was the Spanish Navy (Arma Aerea de la Armada) renaming their Harriers the VA.1 Matador. Serving with Octava Escuadrilla (Esila 008) shore based at Rota or operating from Spain's 15,890 ton aircraft carrier Dedalo (formerly USS Cabot), The Matadors are the main strike force of the Spanish naval air arm and are used in the low level attack role.

It is interesting to note the way the Spanish had to acquire its Harriers. At the time, 1973, Britain had an embargo on selling arms to the Franco regime. In July 1973 the United States Navy ordered six new AV-8As and two TAV-8As, with delivery beginning in 1976. The new machines were immediately put into Marine Corps service, training Spanish naval pilots! Since the Spanish pilots had been limited to light fixed wing and helicopter experience they were first introduced to jet flying with a training course in the TA-4J Skyhawk. In December 1976, after the Spanish pilots were fully trained, seven Harriers (one machine had been lost in a training accident) were sold to Spain and flown to Rota.

Built to USMC standards, the Matadors are essentially AV-8As painted in The Spanish Navy's Gray and White color scheme. Under the Spanish designation VA1 (single seater) and VAE.1 (two seater) initial results of the Harrier's capabilities were found to be very favorable within the Arma Aerea de la Armada, prompting Navy planners to consider a total Matador force of up 24 aircraft. In 1980 an additional five single seat Harriers were purchased directly from Britain as part of this plan.



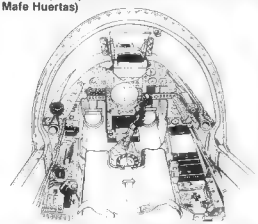
Squadron crest of 8a Escuadrilla, the Spanish Harrier Squadron. Even after being repainted in Spanish colors English language stenciling is on the VA.1 Matador. (Salvador Mafe Huertas)

The Spanish VA.1 Matador is an AV-8A with a new coat of paint. 008 ⊙ 5 in a sparkling new light Gray over White Spanish color scheme, over flies the Mississippi prior to being flown to Spain. (McDonnell Douglas)

(Above) 008 ☉ 5 preparing to take-off from the Spanish Naval Air Station at Rota. Early in 1980, 'MARINA' was removed from the VA.1, being replaced with 'ARMADA'. The five aircraft ordered directly from Britain have carried only 'ARMADA'. (Salvador Mafe Huertas)

(Above Right) 008 ☉ 5 returning from a training sortie, is in a hover prior to landing at Rota. 100 gallon drop tanks are attached to the inboard pylons, while multiple ejector racks are on the outboard pylons. (Salvador Mafe Huertas)

AV-8A
VA 1
cockpit



(Right) A Matador pilot prepares to enter the cockpit of Black 10 aboard the aircraft carrier Dedalo in 1980. Formation strip lights have been added to the nose and tail in a manner similiar to USMC Harriers. This is possibly one of the aircraft ordered directly from Britain. Armada can be seen painted on the fuselage behind the wing. (Salvador Mafe Huertas)

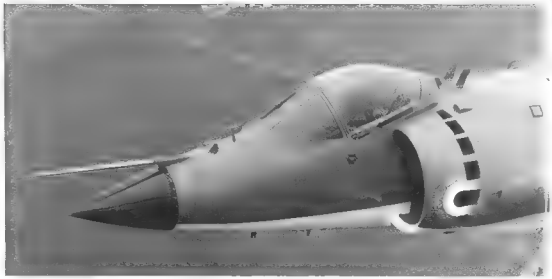
SEA HARRIER FRS MK.1

Near dusk on 8 May 1980, two Argentine Air Force Mirage fighters were shot down by Royal Navy Sea Harriers. The Sea Harriers, one each from the Invincible and Hermes, scored their kills within 20 minutes of each other. It was the pilot from Invincible's 801 Squadron who claimed the first air victory of the Falklands War and had the honor of drawing first blood in the Harrier, "I saw my missile (AIM-9L Sidewinder) hit the back of the enemy aircraft and it exploded...just as advertised!" Later that same evening a third Argentine aircraft, this time a Camberra bomber, was shot down by another Harrier from 801 Squadron.

The American made AIM-9L Sidewinder, carried on the outboard pylons of the Sea Harrier proved their technological worth in these limited air engagements. During one of the most spectacular battles, four Mirage fighters were shot down with only three Sidewinders, fired from only two Sea Harriers. Sweeping in low over the islands to attack British ships during the Port Darwin and Goose Green actions, the four Argentine Mirages were met by the only two Harriers available to counter the attack. The lead Harrier fired his first Sidewinder and then his second; each missile found a Mirage. Simultaneously the second Sea Harrier fired his first Sidewinder, it also found a Mirage, but before the pilot could launch his second missile the fourth Mirage, trying to escape an almost certain fate, banked into the debris of the other Mirages and went down.

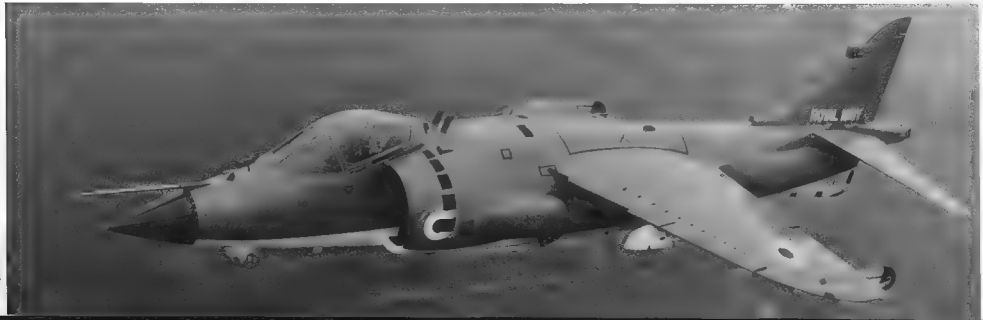
By Wars end in mid June, between 100 and 105 Argentine aircraft and helicopters had been destroyed. Of this number, according to a Ministry of Defense official, neary two-thirds are claimed and credited to Harriers. The final accounting of the Harrier's role in the Falklands fighting will no doubt be determined in detail by future historians, for the present suffice to say...The Harrier proved its worth!

Paul Jackson, in an excellent article on the Harrier, points out that "After its versatility, the most remarkable aspect of the Sea Harrier is the length of time taken to adapt the basic Harrier design for naval strike operations." Carrier trial after carrier trial has been conducted, no less that 24 separate tests, beginning with the P.1127 XP831 prototype landing on the HMS Ark Royal in February 1963. The results were always the same — outstanding! However, little official interest was forthcoming from the Royal Navy and



The new FRS MK.1 cockpit, raised 11 inches higher than the GR 3 and with a new bubbled canopy provides much improved all-around visibility for the pilot including much needed improvement in downward visibility. To reduce length for shipboard storage the pitot tube was moved from the tip of the nose to a position above the nose overlapping the nose cone. (British Aerospace)

The initial production Sea Harrier, XZ450, demonstrates VIFFing (thrust Vectoring in Forward Flight) over the English countryside. Note the downward position of the forward port exhaust nozzle. XZ438-440, the first three aircraft scheduled to be built were designated as prototypes, however, on 20 August 1978, XZ450, the first production machine was in fact the first Sea Harrier to take to the air, XZ438, designated the first prototype, did not fly until year's end. (British Aerospace)



The business end of the FRS MK.1 Sea Harrier provides an excellent view of the large air intakes needed for V/STOL. Except for the huge intakes the Harrier is an exceptionally sleek design. (British Aerospace)

(Below) The rugged landing gear of the Harrier required no modification for carrier use other than the addition of tie down lugs and an emergency brake system. The main and nose wheel doors remain closed except when the landing gear is lowering or retracting or being serviced. The nose cone and pitot tube will fold open to the port to provide easy servicing and a 5.3 ft. reduction in length during stowage aboard ship. (British Aerospace)

XZ450, with exhaust nozzles vectored downward, goes into a hover just before landing. The main gear doors are open and the main wheels are beginning to descend, as are the outrigger wheels. (British Aerospace)

other than the ill-fated 1154 project little effort was made toward taking the Harrier to sea. However, the Labour government's cancellation of the 50,000 ton CVA-01 fleet carrier, the 'unacceptable cost' of refitting HMS Eagle for Phantom II operations, and the widening role for shore based maritime aircraft, all created a need for a V/STOL aircraft to operate alongside the helicopter force. The decision was made to reduce the range and capability of the Royal Navy aircraft carrier forces and bring it more in line with Britain's role in NATO. The conventional carriers already in inventory were to be operated until the expiration of their hull life and then be replaced by the new Anti-Submarine Warfare (ASW) Cruisers. These ASW Cruisers or 'through-deck' Cruisers were ideally suited for Harrier V/STOL operations and at a cost that can be more easily afforded by the British government. Considerable impetus to this program was added when the USMC put the Harrier into service. In May of 1975 an order was placed for 24 navalised versions of the Harrier under the designation Sea Harrier FRS MK.1s.

Designed for the Fighter, Reconnaissance and Strike (FRS) roles, the Sea Harrier's first flight was made on 20 August 1978 at Dunsfold and the first delivery was made when XZ451 was delivered to RNAS Yeovilton in 1 June 1979. The Sea Harrier, a derivative of the RAF's GR MK.3, is powered by a navalized version of the 21,500 lb. thrust Pegasus MK 103 under the designation MK 104, and while retaining a 90% commonality with the Gr 3, the cockpit and nose were completely redesigned.

Because of the limited space in the GR 3 cockpit (little has been changed since the P.1127), the additional equipment requirements of the multi-role weapons system brought about a complete revision of the cockpit in order to provide single crew the highest operational efficiency. By raising the pilot seat eleven inches, the cockpit, even with the addition of naval equipment became 'ordered and workable'. The windscreen was raised but unchanged and the GR 3 canopy frame was used with only minor modifications, however the transparency was made a more bubbled shape. Outside dimensions of the cockpit remained the same but the sidewalls were thinned internally to provide additional space. While the new raised seat position provided much improved visibility and somewhat more panel space, a great deal of unpressurized space was provided under the cabin behind the large new nose cone which houses the Blue Fox radar.

While the airframe, engine and mechanical systems of the Sea Harrier may offer a 90% commonality with the GR 3, the avionics package is 90% new. The Ferranti Blue Fox Nav/Attack system is a heavily modified version of the Sea Spray system used in the Lynx helicopter with extensive up-grading of the air-to-air and air-to-surface modes to meet the Sea Harrier's fighter requirements. The latest Martin-Baker Mk 10 ejection seat with zero-zero capability is installed in the Sea Harrier as well as an automatic pilot. A larger Smith's Head-Up Display (HUD) driven by a 20,000 word digital computer not only generates the HUD symbols but also provides flight path and weapons aiming data. The PWR system mounted in the fin and tail cone is essentially the same as the GR 3. The five weapons pylons have been beefed up and can carry all RAF and USMC stores.

Exposure to the salt laden sea air caused further modification requirements.

XZ450, the first Sea Harrier to land on a carrier deck is seen just after recovery on board HMS Hermes. This machine carried out some of the last carrier trials before service introduction of the Sea Harrier. All went well as usual. (HMS Hermes)

Aluminium replaced corrosive prone magnesium parts in both the Pegasus MK 104 engine and in the airframe. A new coat of anti-corrosive extra Dark Sea Grey over White paint was applied. Tie down lugs were added to the undercarriage which was otherwise unchanged, except for the addition of an emergency brake system. The engine received an enhanced water injection system to aid in high weight approaches and recoveries, and improvements were made to the V/STOL handling system for extra stability during turbulence at sea landings.

Developed from an idea presented by Lt. Cmdr Douglas Taylor RN, the ski jump is having a tremendous effect on Sea Harrier operational performance. Land based Harriers had already proven the usefulness of short rolling take-offs which increases the range and payload by decreasing fuel consumption during take-off. By providing a 7 degree raised ramp from which the Harrier can be launched with its nozzles in a downward position; the aircraft gathers upward velocity without using the large quantities of fuel consumed during a normal vertical take-off. The ASW Cruisers Invincible and Illustrious carry ski ramps of 7 degrees, while the Ark Royal and re-built Hermes will have 12 degree ramps and experiments are being conducted on using a 20 degree ramp. To help train naval pilots a ski ramp was installed at Yeovilton, becoming operational in February 1981. RAF pilots, flying GR 3s, trained on the Yeovilton ski ramp prior to their departure for the Falklands.

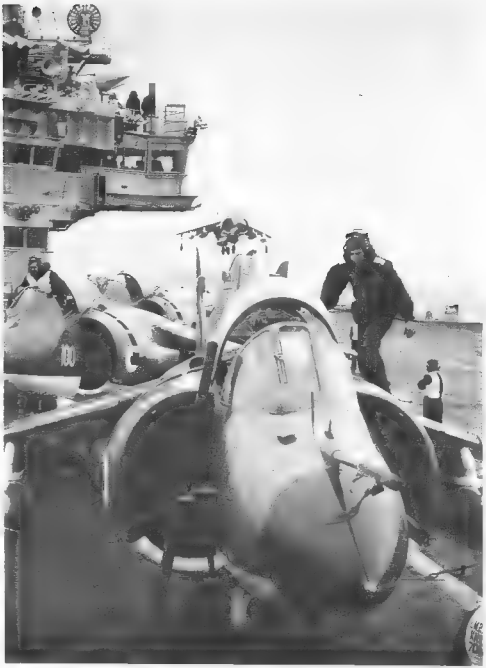
On 26 May 1979 Fleet Air Arm formed an Intensive Flying Trials Unit (IFTU) to begin working the Sea Harrier into Fleet service. Based at Yeovilton which was designated the Harrier home base, the first aircraft was delivered on 18 June 1979 and was coded 100/VL. On 19 September the IFTU was redesignated No.700A Squadron, and after finishing work-up it was redesignated No.899 Squadron on 31 March 1980. Also on 31 March 1980 No. 800 Squadron was established with aircraft coded 250/N, and almost immediately did a tour of duty on the HMS Invincible. Returning to Yeovilton No. 800 Squadron was re-assigned to HMS Hermes and their aircraft were recoded 123/H. No.801 Squadron, commissioned on 26 February 1981, was also assigned to the Commando Carrier Hermes with its aircraft carrying the codes 001/N. No.802 Squadron was to be the third and last of the Royal Navy's Harrier Squadrons, however, war breaking out in the Falklands altered the squadron commissioning schedule and No.809 was unexpectedly commissioned during April 1982 at Yeovilton, leaving 802 still uncommissioned at this writing. No.809 with its aircraft painted in a new overall low visibility semi-matt medium Sea Grey with lower wing surfaces of Barley Grey (Mixed Grey), and new low visibility roundels was immediately sent to the Falklands.

An export order of six single seat Sea Harriers under the export designation FRS MK.51 and two T MK.60 trainers were ordered by India to replace the Hawker Sea Hawks aboard the aircraft carrier Vikerant. To be delivered in late 1982, they will serve with No.306 Squadron. Unlike the Royal Navy, who fly RAF T MK.4 trainers (even painted in the RAF paint scheme), the Indian two seaters have the Sea Harrier cockpit arrangement and nose, the T MK.60 carries most of the Nav/Attack system but not the radar.

No. 700A Squadron (formerly the IFTU) conducted sea trials aboard the Hermes. 101/VL, with its nozzles pointing to the rear prepares for a short rolling take-off. Note that the dive brake is in the open position. (HMS Hermes)

The addition of the tie down lugs allows the Sea Harrier to be lashed to the carrier deck. The glossy extra dark Sea Grey over glossy White is very reflective in the bright morning sunlight. (HMS Hermes)

When the IFTU became No.700A Squadron they adopted a Grey hovering hawk superimposed on a Red A outlined in White, as the squadron emblem. The landing machine in the background is carrying Sidewinder missiles on the outboard pylons. (HMS Hermes)



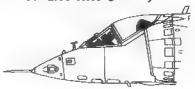
As one Sea Harrier comes in for a landing, others prepare to take off. The ability to operate in low visibility conditions, such as on this foggy day, was one of the Royal Navy's requirements of the Sea Harrier. (HMS Hermes)

Formed on 31 March 1980, 800 Squadron was the first operational Sea Harrier squadron. The squadron emblem on the tail is Red with White trim, the crossed swords and trident are in Gold. With their aircraft coded 250/N No. 800 did a tour of duty aboard the Invincible, upon the squadron's return to Yeovilton, the unit was reassigned to the Hermes and their aircraft were recoded 123/H. Unlike the other squadrons, which carry their aircraft codes on the nose, No. 800 Squadron carries the codes on the air intake. (Lindsay Peacock)

100/VL of 899 Headquarters Squadron equipped with 30MM Aden gun pods and 100 gal drop tanks. 899 Squadron has undergone a further code change when the individual aircraft numbers were changed to the 700 block, the tail codes of VL were not altered. (Bruce H. Johnson)

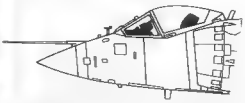
After finishing 'squadron workup' No.700A Squadron was redisignated No.899 Squadron, becoming the Sea Harrier land based headquarters and training squadron. Upon commissioning, on 22 May 1980, the squadron adopted a White winged fist heavily outlined in Black. (MOD)

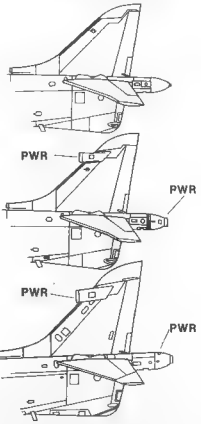
Harrier GR Mk 3 early



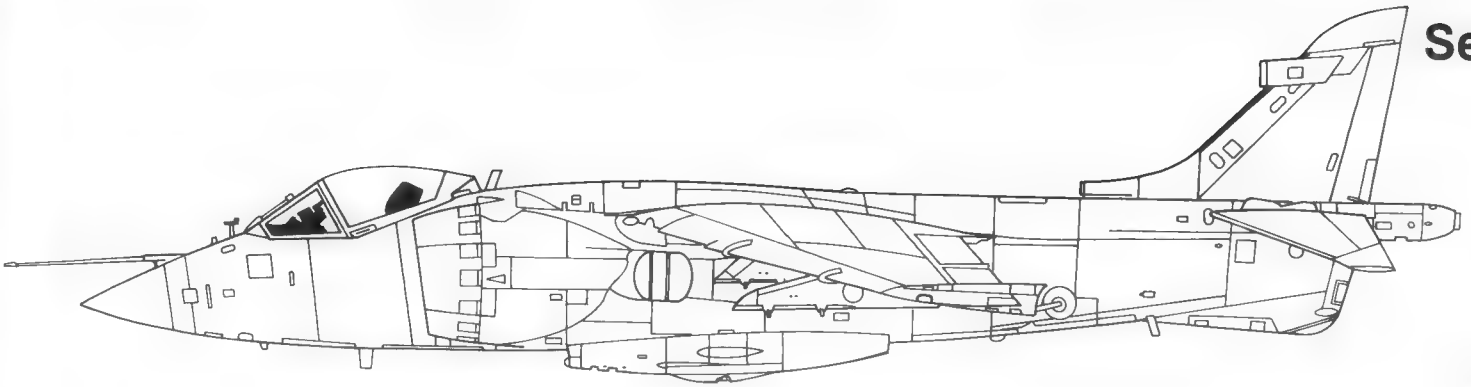
Harrier GR Mk 3
late
with Laser nose

Sea Harrier FRS Mk 1





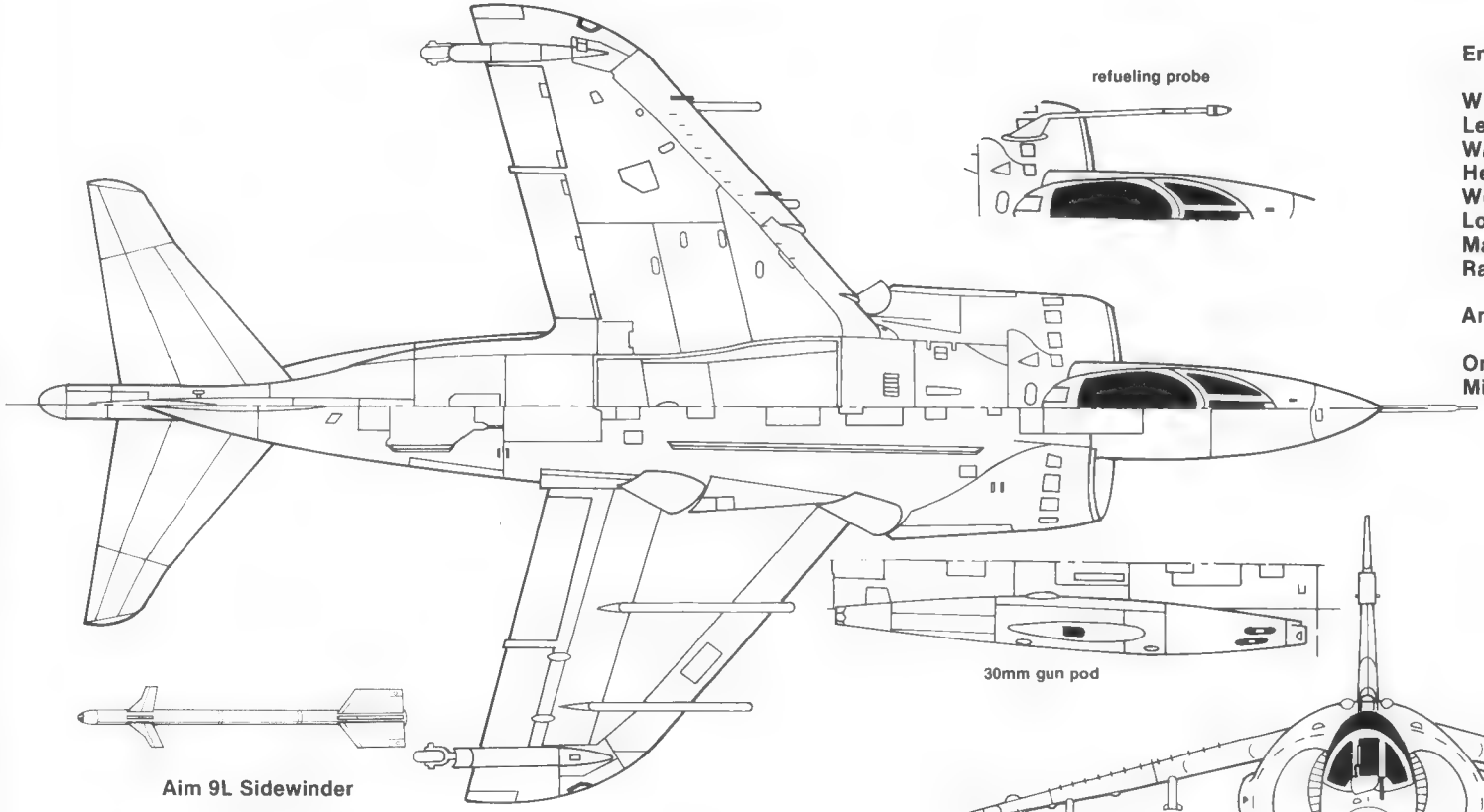
Sea Harrier FRS MK 1



Specifications

Sea Harrier FRS Mk.1

Manufacturer:	British Aerospace
Type:	Single seat fighter, reconnaissance strike, naval aircraft
Engine:	Rolls Royce Pegasus 104, 21,500 lbs. thrust
Wingspan:	25ft 3in.
Length:	47ft 7in.
W/nose folded:	42ft 3in.
Height:	12ft 2in.
Weight:	12,200
Loaded Weight:	23,000
Max Speed:	640 knots plus
Range:	2,000 nautical miles (ferry range)
Armament:	two 30mm Aden guns, two Sidewinder AAM
Ordnance:	6,000lbs.
Mission Radius:	400 miles



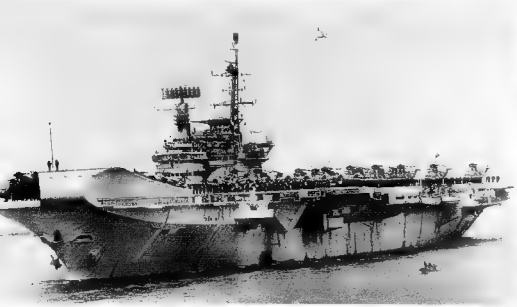
refueling probe

30mm gun pod

Aim 9L Sidewinder

100 gal. Drop Tank

30mm gun pod



As a negotiated settlement was atmpted by Great Britain, HMS Hermes, her deck laden with Sea Harriers and Sea Kings, sams out of Portsmouth in April 1982, heading for the Falklands. (Wide World Photos)

The journey to the South Atlantic Islands held by Argentine troops was spent in training and maintainence, bringing both men and machines to a fine edge, in case they were called upon to go into combat. (Wide World Photos)

(Below) With Sea Kings standing ll a Sea Harrier recovers aboard the Hermes after an attack mission against the airstrip aPort Stanley. Note the empty Sidewinder pylon. (Wide World Photos)

(Below) Black 25 (XZ2459) of 899 Squadron on the deck of the Hermes. All squadron markings have been removed to provide the Argentines with as little intelligence as possible. The usual glossy Dark Sea Grey has been extended to the lower fuselage surfaces and has become very dull with weathering. (Stephen Wolf-Flightlines International)

Black 77 (ZA177) is a Sea Harrier FRS Mk.1 of 809 Squadron, which was hastily formed and immediately added to the Falklands task force. 809 Squadron aircraft were painted in the new low visibility scheme of light Grey with low visibility markings. (Stephen Wolf-Flightlines International)

Painted in the low visibility scheme, Black 94 carries a single Mirage kill marking just above the Light Blue roundel. (HMS Heron via Jerry Scutts)

Returning to England after the surrender of the Argentine forces and the Island has been secured, 899 Squadron is neatly lined up on the deck of the Hermes on 21 July 1982. (Stephen Wolf-Flightlines International)

Black 14 (XZ2457) carries three kill markings, two Mirages and a Skyhawk. Note the addition of waterproof tape over the canopy seal.(Stephen Wolf-Flightlines International)

McDonnell Douglas AV-8B HARRIER II

The Harrier and the U.S. Marine Corps have proven to be a well suited team, with the Harrier literally being able to operate within the sound of rifle fire of the front lines. And although the Harrier has proven to be equal to the tasks imposed upon it by the Corps, the need for increased payload/radius as well as additional VTO requirements for deck launched intercept (DLI), has resulted in the need for an improved version of the Harrier.

As early as 1973 it was suggested that the UK and the U.S. jointly fund the development of an advanced Harrier powered by a 24,500 lb. st Pegasus 15 under the designation AV-16. However, the development cost (over $500 million) of increasing the fan by 2.75 inches and redesigning the fuselage proved to be unacceptable to the two governments and the joint project was dropped with each country developing their own derivitive of the Harrier to meet their own specific needs. The British produced the Sea Harrier; and the U.S., the McDonnell Douglas AV-8B Harrier II.

To meet the Marine Corps need of increased payload and radius of action McDonnell Douglas designed a new lighter, but larger wing built around a new supercritical leading edge and made of graphite/epoxy, which also practically eliminated the problem of corrosian (an important factor in sea operations). New leading edge root extensions (LERX) were added. Increasing the wing span from 25.7 to 30.3 ft. and increasing the cord of the wing allowed internal fuel capacity to be increased by some 40 percent, allowing the Harrier II to carry twice the weapons load half again as far as the AV-8A or the GR MK.3. Large cord single slotted flaps were added to the trailing edge and to aid in working from roads or carrier decks the track of the outrigger wheels was reduced from 22 ft. to 17 ft. The increased wing span allowed an additional pylon to be fitted under each wing with the Sidewinder pylons moving to the wing tips. The increase in wing cord has decreased the speed of the Harrier II somewhat, but given the ground support mission this should not cause undue problems.

With the rejection of the 24,500 lb. powered AV-16, the Sea Harrier's MK 104 navalized engine was modified with a new aluminum alloy fan, a revised intermediate casting that smooths airflow, bigger hydraulic pumps with a gearbox of increased rating to run them, and twin 12 kVA generators. Under the designation Pegasus MK.105, Rolls Royce has estimated that these changes will not only extend the life of the engine by some 25 percent, but will reduce failure rate by 50 percent, cut maintainance manpower in half and reduce fuel costs by over $20,000 per year.

Marine Corps Harrier operations in the past have been STOL, however with the new emphasis upon shipboard deployment the Corps now has the vertical take off (VTO) capacity for deck launched intercept (DLI). To improve the Harrier's VTO performance a second row of suction relief doors were added to the air intakes which were slightly increased in size. Several improvements under the heading of Lift Improvement Devices (LIDs) were added to optimize the ground cushion and to prevent hot gas reingestion the ventral strakes were increased in size and a retractable cross-dam was added. All this resulted in an increase of 1800 lb. in lift, a 1200 lb. increase from the new LIDs and a 600 lb. increase from the extra row of inlet doors on the air intakes.

In a design somewhat similiar to the Sea Harrier, the pilots eye level was raised 10.5 inches and the new canopy provides much broader visibility. The forward fuselage has been redesigned for better equipment storage. Inside the new nose section is a revised Nav/Attack system featuring a Litton ASN-130 inertial navigator, Smith HUD, AYK-4 mission computer, Hughes Angle Rate Bombing System, and an ARN-128 all weather landing system. To counter balance the increased weight of the new nose section the fuselage has been extended 18 inches.

Two YAV-8B prototypes, modified from AV-8A airframes which retained the AV-8A forward fuselage and cockpit, and without the rear fuselage extension, completed flight trials at NAS Patuxent River during late 1980 and were returned to McDonnell Douglas flight test center at St. Louis to continue testing. Unfortunately the second prototype (BuNo 158395), experienced an engine failure durling testing, forcing the pilot to eject. YAV-8B No. 2 was destroyed. The first of four full scale development (FSD) aircraft (BuNo 161396), hovered for the first time on 5 November 1981, and as of this writing three of the prototypes are at Patuxent River undergoing testing.

Current USMC plans call for the procurement of more than 336 AV-8B Harrier IIs to replace the three AV-8A squadrons, and to re-equip five A-4 Skyhawk squadrons. The first AV-8B is not expected to enter squadron service with the Marine corps before 1984. The RAF has ordered 60 AV-8Bs with British instumentation under the designation Harrier GR MK.5.

Full scale mock-up of the AV-8B Harrier II clearly illustrates the increased wing span, two additional wing pylons, the double row of inlet doors around the enlarged intakes, and the LIDs on the lower fuselage. (McDonnell Douglas)

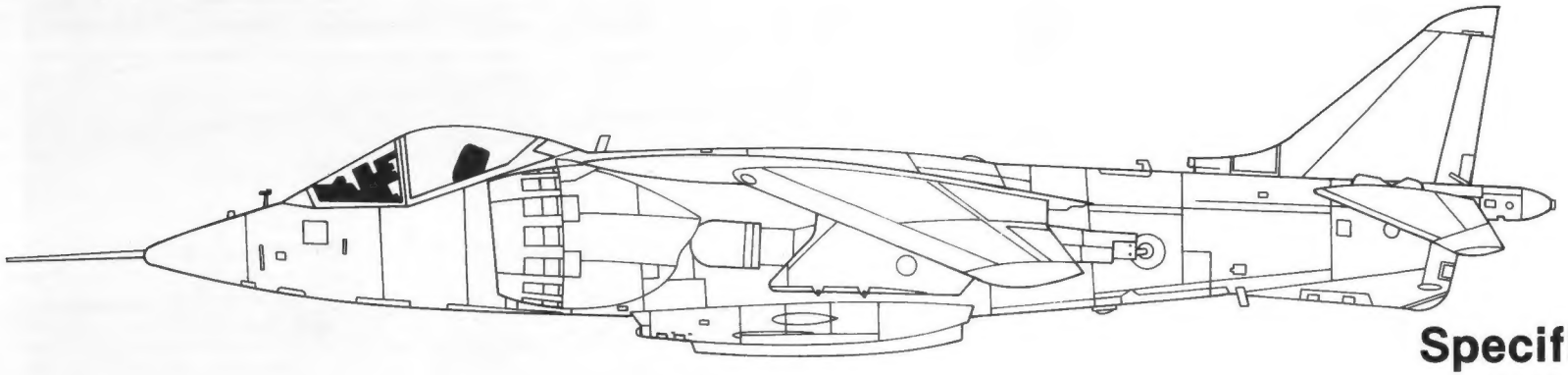
The initial YAV-8B prototypes carried AV-8B painted on the air intake, they were in fact AV-8As rebuilt with the addition of the larger wing, but no change in the cockpit or rear fuselage. (McDonnell Douglas)

Dressed in its Red, White and Blue color scheme, the first YAV-8B prototype carries out a test flight on 12 December 1978. The thickened wing cord with its supercritical leading edge, may slow the AV-8B down slightly, but the wing's increased bulk allows an additional 2000 lbs of fuel and six instead of four weapons hard points to be carried. (McDonnell Douglas)

McAir technicians servicing YAV-8B prototype No.1 at Patuxent River. Visible under the fuselage are the enlarged gun pod strakes, and the retractable dam between the gun pod muzzles. These Lift Improvement Devices provide 1200 lbs. of additional thrust. (Author)

The AV-8As rebuilt into YAV-8Bs had no change made to the cockpit or nose section. By adding a second row of inlet doors, some 600 lbs. additional thrust was achieved in the YAV-8B. (Author)

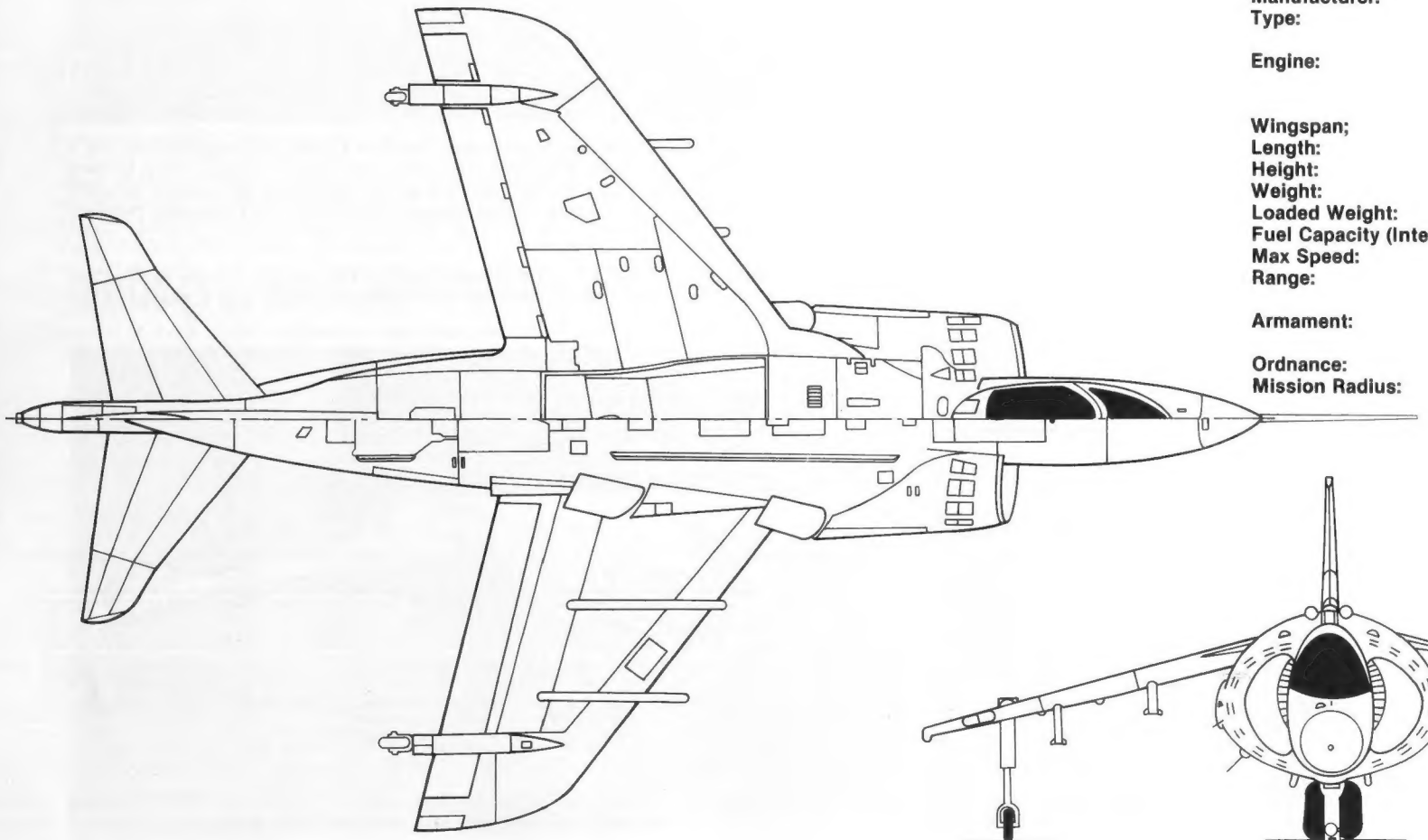
AV-8B



Specifications

AV-8B Harrier

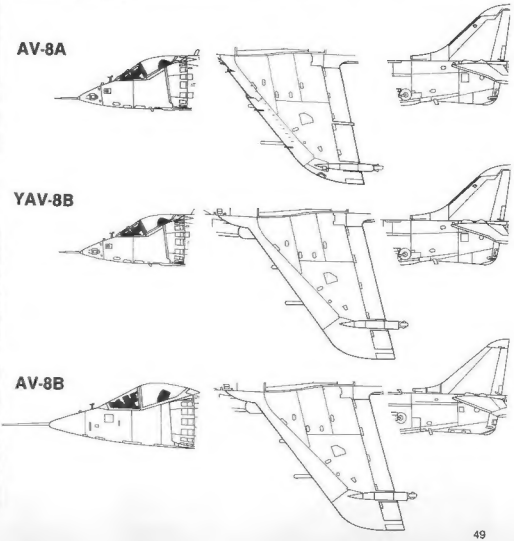
Manufacturer:	McDonnell Douglas
Type:	Single Seat ground attack, strike aircraft
Engine:	Rolls Royce Pegasus 11 Mk.103), 21,500 lbs. st. thrust
Wingspan;	30.3ft
Length:	42.9ft
Height:	11.3ft
Weight:	22,750lb.
Loaded Weight:	29000lb.
Fuel Capacity (Internal):	7,500 lbs.
Max Speed:	640 knots plus
Range:	2,460 nautical miles (ferry range)
Armament:	Two 30mm Aden guns, two Sidewinder AAM
Ordnance:	9,200 lbs.
Mission Radius:	629 miles



Undergoing engine and high angle of attack testing at Edwards AFB is one of the four Full Scale Development AV-8Bs. This full blown Harrier II prototype is painted Red, Black, Gold and White so the position of the control surfaces and attitude of the aircraft can be clearly distinguished during flight tests. The leading edge root extension can be seen as a dark bulge silouted against the sky that runs from the tip of the starboard inboard pylon to the letters V on the air intake. (McDonnell Douglas)

An AV-8A and an AV-8B in formation provides visual evidence of the major differences between the two Harriers, most prominent being the new cockpit area, larger wing, and eighteen inch extension to the rear fuselage. (McDonnell Douglas)

The first of four full scale development (FSD) aircraft during the prototype's first hover at 3:43 CST on 5 November 1981. Five hovers were completed for a total airborne time of approximately 12 minutes. The LIDs on the lower fuselage can be seen to good advantage. (McDonnell Douglas)

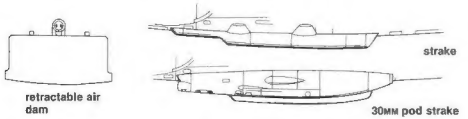


AV-8C HARRIER

With the AV-8B not scheduled to enter squadron service before 1984, it was decided to upgrade existing AV-8As with LIDs developed for the AV-8B. Under the designation AV-8C and beginning in 1979, the first machine to be retrofitted with the enlarged strakes and retractable air dam was BuNo 158384, the very first production AV-8A. Modified AV-8Cs are now undergoing flight trials at NAS Patuxent River and are expected to be phased into squadron service beginning in late 1982 or early 1983.

Besides LIDs, radar warning antennas were installed in the wing tips and tail cone and chaff/flare dispensers were added to the rear fuselage. In addition, the capability to equip with triple ejector racks, a new oxygen generating sytem and a new communications system are all part of the AV-8C update. Nearly 60 AV-8As are expected to be brought up to AV-8C standards by 1984-85.

Lift Improvement devices (LIDS)

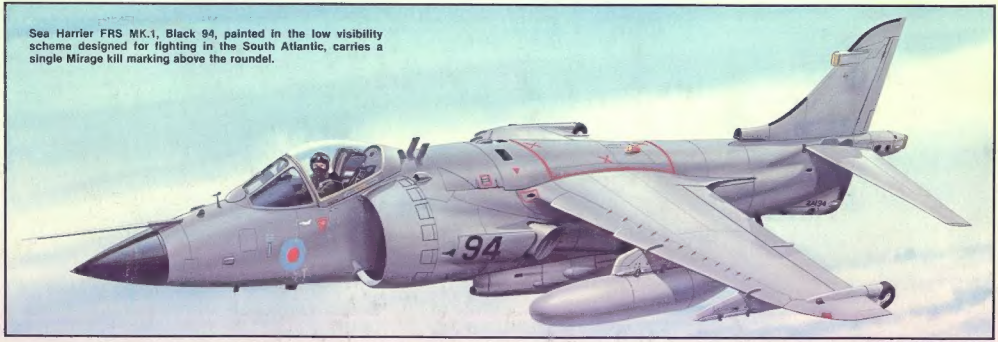


(Above Right) AV-8A BuNo158384 (the first production USMC Harrier) having been modified to AV-8C standards, undergoes testing at NAS Patuxent River in early 1979. (Author)

(Right) AV-8C with lift improvement devices (LIDs) provide the Harrier with nearly 1200 lbs. of additional thrust without upgrading the existing Pegasus engine. The retractable air dam opens as the landing gear comes down. (Author)

(Below) The retrofit to AV-8C standards is an interim measure to extend the Harrier's service life until the AV-8B becomes fully operational. In addition to LIDs, triple ejector racks and radar warning antennas in the tail cone and wing tips will also be added. (Author)

AV-8A of VMA-231 Ace of Spades Squadron in a vertical landing on board the USS Roosevelt.



Sea Harrier FRS MK.1, Black 94, painted in the low visibility scheme designed for fighting in the South Atlantic, carries a single Mirage kill marking above the roundel.

ISBN 0-89747-139-3